OAH Docket No. 12-2500-11342-2
MPUC Docket No. P-999/M-97-909

STATE OF MINNESOTA
OFFICE OF ADMINISTRATIVE HEARINGS

FOR THE MINNESOTA PUBLIC UTILITIES COMMISSION

In the Matter of the State of Minnesota's Possible Election to Conduct Its Own Forward-Looking Economic Cost Study to Determine the Appropriate Level of Universal Service Support

REPORT OF THE ADMINISTRATIVE LAW JUDGE

ON SELECTION OF COST STUDY

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There was no appearance by Sprint at the hearing or in post-hearing briefs.

ABBREVIATIONS AND DEFINITIONS

The following terms used in this report have the stated meanings unless the context clearly requires otherwise:

1996 Act -The Telecommunications Act of 1996, Pub. L. No. 104-104,110 Stat. 56. The 1996 Act amended the Communications Act of 1934, 47 USC §§ 151 *et seq.* Citations are to the relevant U.S. Code section.

ALJ - the undersigned Administrative Law Judge.

AT&T or ATT - AT & T Communications of the Midwest, Inc.

BCPM - Benchmark Cost Proxy Model 3.1, filed January 20, 1998, USW Ex. 27. References to earlier versions will include the version number.

CLEC - Competitive local exchange carrier. Carriers providing or seeking to provide local exchange services using, at least in part, interconnections to an ILEC, purchase of an unbundled network element from an ILEC, or resale of an ILEC's services.

DLC - Digital loop carrier.

DPS or Department - Department of Public Service.

Ex. - Hearing exhibit.

FCC - Federal Communications Commission.

FNPRM - Further Notice of Proposed Rulemaking, In the Matter of Federal-State Joint Board on Universal Service Forward-Looking Mechanism for High Cost Support for Non-Rural LECs, CC Docket Nos. 96-45 and 97-160, July 18, 1997.

Frontier - Frontier Communications of Minnesota, Inc.

GTE - Contel of Minnesota, Inc., d/b/a GTE Minnesota.

HM, HAI Model, or Hatfield Model - HAI Model 5.0a, filed January 30, 1998, AT&T/MCI Ex. 65. The prior version was known as the Hatfield Model 5.0. References to earlier versions will include the version number.

ILEC - Incumbent local exchange carrier. The existing providers of local exchange services. In this proceeding the ILECs are Frontier, GTE, Sprint, and U S WEST.

MCI or MCImetro - MCImetro Access Transmission Services, Inc.

MPUC or Commission - Minnesota Public Utilities Commission.

OAG-RUD or OAG - Office of the Attorney General, Residential Utility and Small Business Division.

Paragraph 250 or ¶ 250 - Paragraph 250 of the Universal Service Order setting forth the FCC's criteria for forward-looking economic cost determinations.

RLCAP - U S WEST's Regional Loop Cost Analysis Program.

Service Area - The geographic area served by a local exchange carrier; the combined areas served by all of its wire centers.

Serving Area or Distribution Area - A small area where all the customers are connected to a serving area interface (SAI). A grouping unit commonly in designing networks.

Sprint - Sprint Minnesota, Inc., f/k/a United Telephone Company of Minnesota, Inc.

Tr. - Hearing transcript.

U S WEST or USW - U S WEST Communications, Inc.

Universal Service - That group of basic local telephone services required to be provided under 47 U.S.C. § 254(c)(1) and Universal Service Order ¶¶ 56-87.

Universal Service Order - Report and Order, In the Matter of Federal-State Joint Board on Universal Service, FCC 97-157,CC Docket No. 96-45, May 8, 1997, as corrected by Errata, June 4, 1997.

Based upon the record herein, the Administrative Law Judge makes the following:

FINDINGS AND CONCLUSIONS

Background

1. It is the policy of the federal and state governments that everyone is entitled to a basic level of telephone service that is affordable. That level of service is referred to as Universal Service and is more specifically defined in the Universal Service Order. It is recognized that the cost of providing Universal Service to customers in "rural, insular, and high cost" areas exceeds what most would consider an affordable price. Historically, Universal Service has been supported through (1) a broad-based set of untargeted subsidies, including the Lifeline and Link Up programs; (2) various support programs, such as the federal Universal Service Fund and the state high cost fund; and (3) untargeted implicit subsidies to the incumbent local exchange carrier, such as geographic deaveraging, the business/residential price differential and high access charges. Now, in a time of emerging competition in all telecommunications markets, the Universal Service mechanism must be explicit, efficient, and competitively neutral. Baker Dir. (Ex. 73) at 4-5; Universal Service Order at ¶¶ 47-48.

2. The 1996 Act changes the telecommunications industry from a regulated industry to a competitive one. As part of that change it is necessary to remove the implicit subsidies for Universal Service and substitute an explicit support subsidy. In general, that is to be accomplished by determining the reasonable cost of providing Universal Service in all geographic areas, identifying those areas that are high cost, and then providing some level of economic support to the Eligible Telecommunication Carriers that provide that service in those geographic areas. The support will be paid out of Universal Service funds or high cost funds, which will be funded by some combination of charges to all telecommunications providers. See, 47 U.S.C. § 254. While the FCC's position is that the competitive marketplace may require some providers to absorb the charges, any ongoing provider will have to generate revenue sufficient to cover all of its costs, so the charges will ultimately be passed on to consumers.

3. In the Universal Service Order, the FCC determined that the level of federal support to be provided in each state for Universal Service should be calculated by determining the forward-looking economic cost of providing the supported services, reduced by a nation-wide benchmark figure. Twenty-five percent of that difference will be paid out of the Federal Universal Service Fund. Forward-looking economic cost will be determined at the state's election according to state-conducted forward-looking economic cost studies approved by the FCC, or by cost models developed by the FCC. Universal Service Order ¶ 223. The FCC required the states to notify the FCC by August 15, 1997, whether they would conduct their own cost studies and, if so, to file them with the FCC by February 6, 1998. Universal Service Order ¶ 248. At the request of several parties, including the MPUC, the FCC extended the deadline for states to file the cost studies to April 24, 1998. Order DA 97-2538, In the Matter of Federal-State

Joint Board on Universal Service, CC Docket Nos. 96-45 and 97-160, December 3, 1997.

4. In ¶ 250 of the Universal Service Order, the FCC established 10 criteria that must be met by cost studies. The FCC also determined that it would review the BCPM and HM and ultimately choose a specific model that it would use as the platform by the end of 1997. Thereafter, it would seek further comment on model inputs and refinements necessary to adopt a complete cost mechanism by August 1998. It also stated that it would issue a Further Notice of Proposed Rulemaking on forward-looking cost methodology to further assist the model developers. Universal Service Order ¶ 245.

5. On July 18, 1997, the FCC issued the FNPRM. That document outlined the elements of modeling forward-looking economic costs and stated tentative conclusions and requested additional comment on many aspects of the models. It set up a schedule for interested parties to submit comments on various subject areas and for it to hold public workshops and issue interim statements on conclusions it reached. It expressed the FCC's expectation that through the process the similarities between the models would increase until one of the models or a hybrid composed of the best features of both models would be sufficiently developed to be adopted as the platform by January 1, 1998. FNPRM ¶¶ 5-7. Contrary to the FCC's expectation, as the models were revised, their cost estimates did not converge. For example, from HM 5.0 to HM5.0a, there were changes in the distribution and switching modules that resulted in more efficient designs for smaller wire centers and, therefore, lower costs. Tr. 593-598.

6. On August 8, 1997, the MPUC issued its Order Electing to Conduct Minnesota-Specific Cost Study and Establishing Deadline in this matter and notice was given to the FCC. On September 19, 1997, the MPUC issued the Notice and Order for Hearing in this matter referring the matter to the Office of Administrative Hearings for a contested case hearing. The Notice and Order for Hearing stated that the ultimate issue was the determination of what the Commission should file with the FCC as its forward-looking economic cost study in compliance with the requirements of the Universal Service Order, and that the proceedings "should produce one statewide forward-looking economic cost study, comprehensive and flexible enough to serve as the basis for calculating the amount of Universal Service support due each present and future eligible service provider."

7. On December 11, 1997, the MPUC issued its Order Granting Reconsideration and Affirming Order of September 19, 1997, affirming the determination that this proceeding should produce one statewide forward-looking economic cost study. While the cost study is denominated as "statewide," it will apply only to "non-rural carriers" in Minnesota, at least initially. This is because the FCC has separated the determination of support mechanisms for the larger non-rural carriers from the mechanisms for rural carriers. In Minnesota, the non-rural carriers are U S WEST, Frontier, GTE, and Sprint. While these carriers provide service in the most densely populated areas of the state, they also provide service in some of the most rural and least populated areas of the

state. Such areas are the highest cost areas and will be areas for which Universal Service support will be provided.

8. In addition, on December 11, 1997, the proponents filed revised models with the FCC. Subsequently, the FCC continued to receive revisions of the models. On February 3, 1998, the FCC published Public Notice DA 98-200 stating that while the changes to the models resulted in valuable enhancements, the continual state of flux compromised the FCC's ability to select a platform in a timely fashion. Therefore, the FCC established February 6, 1998, as the deadline for filing revised versions of the models. Final revisions to the BCPM and the HM were filed with the FCC at that time.

9. This matter came on for hearing before the ALJ on February 9, 1998, in the Minnesota Public Utilities Commission's Large Hearing Room, 121 Seventh Place East, Suite 350, St. Paul, Minnesota. The hearing continued through February 13, 1998. The final briefs of the parties were filed on March 16, 1998.

10. By letter of February 24, 1998, the ALJ reminded the parties that they had agreed to requests from DPS to file the final revisions of their models in this matter, that they should do so, that they should include descriptions of the changes, and that any party could make appropriate objections.

11. A copy of the final revision to the HM, along with revised documentation but no specific explanation of the changes was filed in this proceeding on February 25, 1998. AT&T/MCI Ex. 165 and 166. A copy of the final revision to the BCPM, along with a description of the changes was filed in this matter on March 5, 1998. USW Exs. 167 and 168. On the same date, U S WEST filed an objection to admission of the final revised HM because the changes had not been described, because they had heard rumors about its content, and because they had not had a chance to analyze it. Mr. Merz filed a letter on behalf of AT&T and MCI dated March 9, 1998, arguing that the revised HM should be admitted because Dr. Mercer had described the changes. GTE filed a letter that same day joining U S WEST's objections. On March 11, 1998, DPS filed a letter arguing that the revised HM should be admitted. On March 25, 1998, Ms. Singer filed a letter on behalf of AT&T and MCI explaining the changes in the final revised HM. AT&T/MCI Ex. 169. The final revisions had corrected three errors and included a new "CBGMulti" table. Dr. Mercer had testified at the hearing that none of the changes affected the runs submitted previously submitted in this matter. Tr. 531-533.

12. It is unfair to the parties to base a cost study upon a model the parties have not been able to review in its entirety and cross-examine. It appears unlikely that the changes to the BCPM and the HM will substantively affect results, but that is unknown in this proceeding. DPS suggests that it should be expected that the FCC will have its own viewpoint about the models and their inputs, that the FCC will prescribe some changes either to the models or the inputs or both, and that the FCC will want those changes incorporated into the methodology for estimating costs for the federal Universal Service program. While that may be true, presumably the FCC will have additional evidence properly before it at the time. In this matter, it is necessary to cut off new

evidence at some point so that the parties are treated fairly and so the matter can proceed. Moreover, since there is no effect on outcomes in this proceeding, there is no need to consider the revisions now. The same considerations apply to the BCPM. Therefore, the ALJ will not receive the final revised models for the purposes of this proceeding. Exs. 165-169 are not received.

13. On February 27, 1998, the FCC issued Public Notice DA 98-217 in CC Dockets 96-45 and 97-160, which specified formatting for transmittals by state agencies of their cost studies for Universal Service. There was also a "text document" attached to Public Notice DA 98-217, that included some additional issues to be addressed by the states. Some of those are addressed in this report.

14. As of the date of this Report, the FCC has not issued an order selecting a model as the cost study platform it will use.

Expert Witnesses

15. This matter is largely an evaluation of the testimony of experts employed or retained by the parties. In evaluating their models and testimony, it is necessary to consider the interests of the party that retained them, the experts' financial or other interests in the outcome, their other apparent biases, their knowledge of the subject, the consistency of their testimony with other known facts, and their ability to explain and support their opinions. As described below, the ALJ has chosen to reject all or parts of the testimony of certain witnesses based on the foregoing criteria and not upon whether the witness was cross-examined on a specific subject or specifically rebutted. Contrary to arguments advanced by U S WEST and GTE, a trier of fact is free to reject even unchallenged and unrebutted evidence when the testimony appears not credible. Moreover, the amount and complexity of evidence, combined with financial and time constraints, made testing of every point impossible, so the simple status of being specifically unrebutted is of no particular moment.

16. In evaluating the witnesses, it is necessary to bear in mind the positions and interests of the parties that hired them. U S WEST and GTE have the greatest financial stake in the outcome of this proceeding because the choices made here will directly affect the amount of the subsidies they will receive for providing Universal Service to high cost areas. No other carrier can be expected to provide any significant portion of such service in the near future. As GTE has made clear, it seeks to have the federal Universal Service Fund and state high cost funds pay all of its embedded costs and pay for an upgrade of its network. U S WEST has not been so blatant, but has designed its model, for example, to pay its own current costs for materials and structure. GTE and U S WEST have expended the greatest effort and resources in finding experts to analyze and criticize the opposing model and to support their own. The BCPM they sponsor has been designed with a bias toward overbuilding and higher prices. MCI and AT&T actually have a very small direct stake in this proceeding. Even as they begin providing local exchange services, their penetration into high cost areas will be relatively insignificant. But they are competitors of the ILECs and don't wish to see them given needless subsidies. More importantly, they are also sponsoring the HM in generic cost

proceedings where the cost model will directly determine their costs of doing business. To the extent that selection of the HM here influences selection of the cost model for the generic cost proceedings, they would be benefited. The HM they sponsor has been designed to emphasize the "least-cost" requirement of the cost model standards. The DPS and OAG are proponents of the public interest and therefore can be expected to seek out and endorse the model that designs a network that employs the "least-cost, most-efficient, and reasonable technology" required by the FCC and by state law.

17. Zeuxis is reported to have said about 400 B.C. that criticism comes easier than craftsmanship. Everyone can cite modern versions of that observation. Both the BCPM and the HM are skillfully and artfully designed, and both are incredibly complex models that perform well the tasks for which they were designed. Both contain logic designs and input values that bias them toward the outcomes desired by their sponsors. The critics here serve a valuable purpose of highlighting the weaknesses and errors that occur in the models. But the task here is to select the better cost study; throwing out both models is not an option. Witnesses that provided comparisons between the models were far more helpful to the selection process than those who only provided criticism of the model opposed by their clients.

18. Peter B. Copeland was presented by U S WEST as an expert on the BCPM. He has a Bachelor of Arts Degree in Urban Studies and a Master of Public Administration. He is employed by U S WEST in Denver, Colorado as Director, Universal Service Cost, in U S WEST Public Policy Organization. USW Ex. 28 (Copeland 2/3/98) at 1. He has worked for 16 years for U S WEST and Bellcore. Mr. Copeland is extremely well qualified to speak about cost models in general, and the BCPM in particular. He developed the U S WEST High Cost Fund Targeting Model, which was the first geographically-based cost model of basic local service and the predecessor to the Benchmark Cost Model. He has continued in the development of cost models and is one of the principle developers of the Benchmark Cost Model 2, the Benchmark Cost Proxy Model, and the latest versions of the Benchmark Cost Proxy Model referred to in this proceeding as the BCPM. Mr. Copeland is also the U S WEST representative on the Telecommunications Industry's Analysis Project and, as such, a major contributor to its research papers on Universal Service, rate deaveraging, interconnection, and loop costs. USW Ex. 16 (Copeland 10/24/97) at 3-4; USW Ex. 17, PBC-1 (10/24/97).

19. Mr. Copeland's testimony was open and direct and his opinions were clear, well explained, and based upon a high degree of knowledge of the BCPM networks, and network modeling.

20. Dick Buckley was offered by U S WEST to provide testimony supporting the reasonableness of the outputs provided by BCPM. He is employed by U S WEST as a manager-loop cost analyst. He has a BA in Finance, joined Mountain Bell in 1980 as a cost analyst and in 1986 moved into Cost Analysis of the local loop and assisted in the development of the RLCAP (Regional Loop Cost Analysis Program). USW Ex. 30 (Buckley 10/24/97); USW Ex. 31, RJB-1 (10/24/97).

21. Mr. Buckley appeared to testify very credibly; his testimony was clear and understandable.

22. Mark D. Schmidt was offered by U S WEST to support the BCPM with respect to engineering assumptions, particularly about cable placement, sizing, and structure sharing. He is a planning specialist with U S WEST in Littleton, Colorado, with the title manager-interconnection strategies. He has one year of college and 19 years of experience with Mountain Bell and U S WEST, primarily doing outside plant local loop planning and engineering. U S WEST Ex. 47 (Schmidt 10/24/97); U S WEST Ex. 48, MDS-A (10/24/97).

23. Mr. Schmidt appeared quite knowledgeable in his area of expertise and his testimony was understandable and reasoned.

24. James S. Shaaf was offered by U S WEST as an expert on loop design and in support of the BCPM. Mr. Shaaf has an Associates Degree in Business Administration from San Bernardino College. He worked for the Bell System, Nevada Bell, and Pacific Bell for 32 years and retired from Pacific Bell in 1995. He was in construction for 15 years and engineering for 17 years. He has extensive experience in loop construction, loop planning and loop modeling. Since 1995, he has served as a loop engineering consultant with INDETEC and, as such, assisted INDETEC and Pacific Bell in their joint development of the Cost Proxy Model and then the BCPM. USW Ex. 36 (Shaaf 10/24/97); USW Ex. 37, JSS-1 (10/24/97).

25. Robert A. Mercer was offered by AT&T and MCI in support of the HM. He has a BS in Physics from Carnegie Institute of Technology and a Ph.D. in Physics from Johns Hopkins University. Dr. Mercer was an assistant professor of Physics at Indiana University until 1973 when he joined Bell Telephone Laboratories. From then until 1984, he held a variety of positions in network planning organizations at Bell labs and AT&T. His final position at Bell labs was the Director of the Network Architecture Planning Center. Upon the AT&T divestiture, he joined Bell Communications Research (Bellcore) in January of 1984. He then worked at BDM Corporation and AT&T Bell Laboratories until 1987, when he joined Hatfield Associates, Inc. That firm specialized in engineering, economic and policy studies in the telecommunications field and he worked there as senior consultant, senior vice president and president of the firm. AT&T/MCI Ex. 51 (Mercer 10/24/97) at 1-3. In October 1997, the former principals and employees of Hatfield Associates, Inc. formed a new firm named HAI Consulting, Inc. Dr. Mercer serves as president of HAI Consulting, Inc. AT&T/MCI Ex. 59 (Mercer 12/17/97) at 1. All the former principals and employees of Hatfield Associates, Inc. who worked on the development of the Hatfield Model continue as employees of HAI Consulting, Inc. Dr. Mercer holds an adjunct faculty position in the Interdisciplinary Telecommunications Program at the University of Colorado.

26. Dr. Mercer's testimony was extremely credible. He is extremely knowledgeable as to the HM and the design of telephone networks. His testimony was clear and understandable, although his responses to some cross-examination were sometimes sarcastic and arrogant. While his testimony was given on behalf of AT&T and MCI, and

clearly supportive of "his" model, it appeared to be the least biased testimony given by any of the experts appearing on behalf of any of the parties.

27. Dean R. Fassett was offered by AT&T and MCI to support the outside plant engineering assumptions and default parameters used in the HM. Mr. Fassett worked for NYNEX for over 26 years, retiring in May 1996. He was an Engineering Manager and then an Area Operations Manager for NYNEX with responsibilities for outside plant engineering and construction. During his career, he attended many training courses for engineering and construction of outside plant. He is presently the owner of Adirondack Telcom Associates, providing telecommunications consulting services to AT&T and MCI concerning outside plant infrastructure design, construction, and the costing aspects of the local loop. AT&T/MCI Ex. 66 (Fassett 10/24/97) at 2-4. Mr. Fassett was retained by AT&T and MCI as part of a team employed to provide and verify inputs to the HM. Mr. Fassett's role was to review outside plant inputs, default values and assumptions within the HM for reasonableness and to review the methodology used by the HM in comparison to acceptable engineering practices. Additionally, he has reviewed some input values and assumptions in the BCPM and the RLCAP. AT&T/MCI Ex. 66 (Fassett 10/24/97) at 4-5.

28. Mr. Fassett appeared quite knowledgeable about loop construction and the pricing of loop components. He appeared credible and reasonable in his determinations of the costs an efficient ILEC would incur in building a least cost, most efficient network using currently available technology.

29. Richard D. Emmerson was presented by U S WEST for the purpose of critiquing the HM and for doing a comparative analysis of the HM and BCPM. Dr. Emmerson has BA and MA degrees in Economics and received his Ph.D. in Economics from the University of California, Santa Barbara, 1971. From 1971 through 1979, he was a full-time assistant professor in the Economics Department of the University of California, San Diego. Since 1979, he has continued to teach part-time there. Since 1979, he has worked as a consultant in the telecommunications industry and has provided expert testimony in over 60 telecommunications regulatory proceedings and 17 other cases pertaining to economic policy. Since 1986, he has been president and CEO of INDETEC International, a firm that provides consulting and training services to domestic and international telephone companies. INDETEC is one of the developers, along with U S WEST, Sprint, and Bell South, of the BCPM. USW Ex. 1 (Emmerson 10/24/97) at 1-2; USW Ex. 2, RDE-1 (10/24/97). Dr. Emmerson presented two studies of the HM that had been completed by INDETEC. USW Ex. 4, RDE-1 (11/24/97) and USW Ex. 6, RDE-1 (1/23/98).

30. Dr. Emmerson testified very credibly. His opinions appeared to be well informed and logical and he answered questions on cross-examination directly and clearly.

31. William L. Fitzsimmons was offered by U S WEST to present a criticism of the HM. He has a BS in Economics, an MS in Resource Economics, and a Ph.D. in Resource Economics from the University of Massachusetts, Amherst, Massachusetts, which he also describes as a Ph.D. in Applied Economics. He was previously employed

by AT&T in Market Analysis and Forecasting and Bell South Corporation as a Corporate Economist and Senior Economist. From 1993 to the present, he has been employed by LECG, INC. as a Managing Economist, Senior Managing Economist and, since January 1998, a Director. LECG, INC. and Dr. Fitzsimmons provide economic consulting to telecommunications providers, much of it in the area of financial simulation models and cost models. USW Ex. 45 (Fitzsimmons 1/23/98); USW Ex. 46, WLF-1 (1/23/98).

32. Dr. Fitzsimmons testified very credibly. He is very knowledgeable in the area of cost modeling and his opinions and analyses appear to be well done and fairly well explained. His task, as he testified, was to provide criticisms of the HM and he carried that out well.

33. John C. Klick was offered by AT&T and MCI to present a critique of the BCPM, respond to criticisms of the HM, and present some comparative evaluation of the two models. Mr. Klick received a BS Degree in Mathematics from Bates College and has taken graduate courses in Accounting, Finance, and Operations Research. After graduation, he joined the Cost and Statistics Department of the Southern Railway System. Since that time, he has been involved in cost analysis of various industries. He has extensive experience with large, computerized databases and cost models. He is currently president of Klick, Kent & Allen, Inc., an economic and financial consulting firm. The firm has been retained by AT&T and MCI to assist in presenting and analyzing cost evidence in various state proceedings. AT&T/MCI Ex. 80 (Klick 1/23/98) at 1-3.

34. Mr. Klick's testimony was extremely credible. His understanding of the models and his ability to explain his opinions were the among the best of all the witnesses.

35. Gregory M. Duncan was offered by GTE to present a criticism of the HM. Dr. Duncan has a Masters in Statistics and a Ph.D. in Economics, both from the University of California, Berkeley. He was an assistant professor of Economics and Statistics at Northwestern University in Evanston, Illinois, and then a professor of economics in Statistics at Washington State University. His particular expertise includes the formulation, specification, estimation, and testing of cost models. He worked for GTE Laboratories, Inc., where he was a staff scientist in its Department of Economics and Statistics. He is presently employed by National Economic Research Associates (NERA) as vice president. GTE Ex. 94 (Duncan 11/24/97) at 1-2; GTE Ex. 96 (Duncan 1/23/97) at 1-2. There is no description of an NERA in the record, but it appears to be an economic consulting firm.

36. Dr. Duncan presented an analysis of HM 4.0, GTE Ex. 95, and an analysis HM 5.0, GTE Ex. 97. The analyses were authored by Dr. Duncan and others from NERA. Also authoring the analyses was Network Engineering Consulting, Inc. (NECI), including Robert P. Cellupica, the witness discussed next. There is no description of NECI in the record.

37. While Dr. Duncan's background was very impressive, his testimony was the least credible of all the witnesses. His responses on cross-examination were often

argumentative and unresponsive. Several of his conclusions were based upon economic theories contrary to those accepted by virtually all of the other experts in this matter and contrary to the requirements for cost studies adopted by the FCC and by the Commission. Some of his criticisms of the HM were based upon flawed understandings of the HM. He did not validate his criticisms of the HM by showing how they applied to the BCPM. There are, no doubt, portions of Dr. Duncan's testimony that are correct and well reasoned. But it is not easy to sort through his testimony and make such determinations and the burden is not upon the ALJ and Commission to do so. Therefore, the ALJ has placed virtually no reliance upon his opinions, even those that were uncontradicted in certain details. There were few major opinions expressed by Dr. Duncan that were not contradicted by other evidence, the law, FCC or Commission requirements, or common sense.

38. Robert P. Cellupica was offered by GTE to provide a criticism of the HM engineering inputs and methodology. He cosponsored the analyses of HM 4.0 and HM 5.0 prepared by NERA and NECI. Cellupica was also previously employed by NYNEX (now Bell Atlantic) for 26 years in various managerial and engineering positions in which he performed loop engineering support functions, was responsible for a Loop Technology Planning Group, had responsibility for vendor selection for Loop Technology equipment, and held positions in network design, asset management, field technical support and outside plant construction. He received a BS in Electrical Engineering from the University of New Hampshire and an MBA from Babson College. He is currently employed by NECI as a consultant specializing in engineering related to the telecommunications industry. GTE Ex. 99 (Cellupica 11/24/97) at 1-2; GTE Ex. 100 (Cellupica 1/23/98) at 1-2.

39. Mr. Cellupica was fairly credible and knowledgeable. However, parts of his critique of the HM were based on his position, like that of all the GTE witnesses, that the input costs of equipment, materials, and labor should be based upon average cost rather than least cost, and upon the actual costs of the company whose service area is being studied, as opposed to the costs of an efficient provider. Since these positions are not consistent with the standards to be applied in this proceeding, his testimony must be discounted.

40. Garth M. Morrisette was offered by the OAG to provide an evaluation of the models in this proceeding and to make recommendations regarding the use of the models. He received a BS Degree in Economics from the University of Oregon, an MS Degree in Economics from the University of Wyoming, and has completed Ph.D. level course work in Micro- and Macro-Economics, Public Utility Regulation, Environmental Economics and Regional Economics. He has been employed as an Economist in the Residential and Small Business Utilities Division of the Office of the Attorney General since 1992. OAG Ex. 109 (Morrisette 11/24/97) at 1-2.

41. Mr. Morrisette was a credible witness and provided a considerable amount of unbiased analysis. His testimony suffered somewhat from the fact that he was yet to come to conclusions on several issues and because some of his opinions were based upon misunderstandings of some of the models' processes.

42. Wes Legursky was offered by the DPS to provide a comparative analysis of the models in this case. He has a BS in Industrial and Systems Engineering from Ohio State University. After receiving his degree, he was employed by Ohio Bell Telephone for six years as an engineer in Transmission Engineering, and then as a manager in Strategic Planning. He provided new technology assessment for network equipment and systems, was responsible for technical support of new service deployments, and represented Ameritech on national committees related to those topics. He worked for Ameritech Services, Inc. from October 1987 to February 1994, as director of Fundamental Network Planning and then director Architecture Planning. In those positions he provided network planning support for the Ameritech operating companies in switching, transmission systems, outside plant, numbering, signaling and forecasting, and then provided direction on the evolution of the Ameritech network. From March 1994 to October 1995, he worked as an independent consultant, which included developing analytical models for new and existing telecommunication architectures. From November 1995 to June 1997, he was a Director, Engineering, for Intelligent Object Solutions providing engineering and business support to a start-up company that developed wireless intelligent network software. He returned to independent consulting in July 1997. DPS Ex. 112 (Legursky 1/23/98) at 1 and Attachment I.

43. Mr. Legursky's testimony was extremely credible. He is very knowledgeable in telephone network design and in modeling. On a few occasions, his opinion of the reasonableness of certain cost inputs seemed to be based upon very rough estimates supported only by memories of general impressions. Nonetheless, the ALJ found his analysis unbiased and his views very sound, and has relied upon his opinions to a great extent.

44. U S WEST criticized Mr. Legursky, as it must because he chose to endorse the HM. It points to the fact he chose the HM before he was able to get BCPM running, and argues that there is little foundation for some of his opinions. It remains clear to the ALJ that Mr. Legursky came into this project with an open mind, evaluated the models fairly, and adjusted or confirmed his opinions as new evidence became available to him. He reviewed the profiled testimony and sat through most, if not all, of the hearing. The ALJ specifically rejects U S WEST's arguments that Mr. Legursky, and DPS, were advocates for the HM and that their opinions should be discounted and their procedural rights limited because of that. *See, e.g.* USW Reply at 29-30. It is abundantly clear that Mr. Legusky and DPS are recommending the HM after, not before, an unbiased examination of the models. Their recommendations have been viewed in that light.

45. Edward Fagerlund was offered by DPS to evaluate certain aspects of the cost studies in this proceeding and to summarize DPS's recommendations. Dr. Fagerlund has a BS Degree in Mathematics from the University of Michigan and a Ph.D. in Economics from the University of Minnesota. His areas of concentration in graduate school included applied Micro Economics and applied Econometrics. He has taught several courses in Economics and Public Finance in several area universities. Dr. Fagerlund began working for DPS in 1985 and has appeared before the Commission and authored reports of DPS on numerous issues, including pricing and costing issues. DPS Ex. 115 (Fagerlund 1/23/98).

46. Dr. Fagerlund's testimony was credible and unbiased. His analysis, particularly in economic areas, was particularly helpful and complimented Legursky's testimony on modeling and network design.

47. The FCC is also a source of independent expert analysis in this matter. It has a large staff of doctorate-level economists and other expert analysts familiar with telephone networks and costs. The open process used by the FCC in encouraging the development of effective cost models created a dialog of experts observable by interested parties. Some of the FCC staff have developed cost model modules themselves. FCC Public Notice DA 97-2712, Common Carrier Bureau Announces Release of HCPM Version 2.0, CC Docket Nos. 96-45 and 97-160, December 29, 1997. The cost study requirements created by the FCC are appropriate for Minnesota and have been very helpful in evaluating the studies offered in this proceeding.

Least-Cost, Most-Efficient, and Reasonable Technology

48. Universal Service Order ¶ 250(1) states: "The technology assumed in the cost study or model must be the least-cost, most-efficient, and reasonable technology for providing the supported services that is currently being deployed A model, however, must include the ILECs' wire centers as the center of the loop network and the outside plant should terminate at ILECs' current wire centers. The loop design incorporated into a forward-looking economic cost study or model should not impede the provision of advanced services. For example, loading coils should not be used because they impede the provision of advanced services. We note that the use of loading coils is inconsistent with the Rural Utilities Services guidelines for network deployment by its borrowers. Wire center line counts should equal actual ILEC wire center line counts, and the study's or model's average loop length should reflect the incumbent carrier's actual average loop length."

49. Both models generally have reasonable technology and place plant from wire centers at their existing locations. They employ loop designs that do not impede the provision of advanced services. Both models have as a goal the accurate estimation of the forward-looking cost of a network designed to provide efficiently the supported services. The BCPM can meet the requirement that wire center counts equal actual ILEC wire center line counts if the counts are provided; the HM can be modified to do so. Both models produce average loop length figures.

Determining Customer Location

50. The two models approach determining customer locations differently. Accurate estimation of customer location, usually in terms of clusters of customers, enables more accurate design and cost estimation of the feeder and distribution plant necessary to serve those customers. Since feeder and distribution costs make up a majority of network costs, accurate determination of customer location is critical to accurate determination of network costs. Therefore, the issue will be discussed at some length.

51. At the time it issued its FNPRM, the FCC tentatively concluded that the HM provided a better algorithm for determining population distribution because it took population clusters into account. In addition, the FCC tentatively concluded that such clusters must be accurately located with respect to their serving wire centers in order to estimate costs accurately. FNPRM, ¶¶ 36, 44. The BCPM filed in this proceeding calculates the proximity of population clusters to the wire centers with far more precision than the version of the BCPM that the FCC considered in the FNPRM.

52. The BCPM constructs customer locations based on a preprocessing procedure that combines wire center boundary locations and census block housing and business data with road data contained in the TIGER database. The approach is based on the notion that people live on or near certain types of roads, a notion that has been verified empirically by Dr. Emmerson. Ex. 7, pp. 10-11.

53. The BCPM first overlays the region under study with a grid structure, each cell of which is called a microgrid and is approximately 1,500 feet by 1,700 feet. It then assigns census blocks to microgrids. Some census blocks fit entirely within a single microgrid while others lie across two or more microgrids. Tr. 13-14. Not all census blocks contain customer locations. If a census block containing one or more customer locations fits within more than one microgrid, the housing units must be assigned to a particular microgrid. Two assignment methods are used. For CB's smaller than 1/4 square miles, assignment of customer locations is done on the proportion of the CB's land area within each microgrid. For CB's 1/4 square miles in area and greater, assignment is done according to the proportion of the CB's roadways within each microgrid. USW Ex. 25 (Copeland 1/19/98) at 24. This latter assignment process assumes that there is an equal probability that all customers will be located on any given segment of road contained in the Tiger database Tr. 27. The BCPM road centroid methodology assumes that all customers are located within 500 feet of a roadway Tr. 30. The assignment algorithm calculates the percentage of the area of a census block's road network within each microgrid that intersects the census block and assigns that percentage of the customers within the census block to the corresponding microgrid. The area of a census block's road network is calculated as road length times 1000 feet (500 feet on each side of the roadway). At this point, customers are assigned to a single microgrid.

54. The next step of the process aggregates microgrids into larger grids. The aggregation process is an iterative one that limits aggregation where technological constraints become binding. USW Ex. 25 (Copeland 1/19/98) at 28. The result of the aggregation process is the creation of "ultimate" grids. The ultimate grid cells are then segmented into four distribution quadrants defined by the road "centroid" of the grid. Another road centroid is then computed for each distribution quadrant. Id. at 30-31. The final step in locating customers involves clustering them. The model calculates the road area and road centroid within each distribution quadrant containing customer locations and produces a "road-reduced" quadrant, a square whose area equals the road area of the distribution quadrant and whose center is placed at the road centroid of the distribution quadrant.

55. The BCPM then places distribution facilities, based on concentrations of populated microgrids. The ultimate grid which becomes the representation of the carrier serving area, may be as small as four microgrids or as large as sixty-four. The plant placed includes a digital loop carrier at the road centroid of the ultimate grid, with feeder running to each of the occupied quadrants of that ultimate grid, which represent distribution areas. In each quadrant, assuming sufficient population exists in the quadrant, a feeder-distribution interface is placed at the road centroid of the quadrant, and distribution plant is built to serve a square which is equal in area to the lengths of the roads in the occupied microgrids, multiplied by one thousand feet. This plan accounts for customer clustering or dispersion and location within a serving area by building smaller or larger distribution areas and moving them to the road centroids of the occupied quadrants. USW Ex. 26, Ex. PBC-4 at 35-41.

56. In contrast to the BCPM, the HM uses geocoded location data to locate customers within census blocks. The HM has geocoded location information for over seventy percent of Minnesota telephone subscribers. Tr. 953; Ex. 130 (Affidavit of Richard Clarke). The remaining customer locations for which no geocodes are available must be estimated by a surrogate location methodology. The HM assumes that such customers are located an equal distance from each other on the exterior boundary of the census block. Tr. 514-16; AT&T/MCI Ex. 65, RAM 15 (Mercer 1/20/98) at 36. This assumption is appropriate because of the strong relationship between the road network and census block boundaries. Further, when significant numbers of households are not located on a census block boundary, a new census block is created in the interior of the old census block and its boundaries are roads, as shown in Ex. 64. Tr. 345; AT&T/MCI Ex. 64, RAM 20 (Mercer 1/23/98); AT&T/MCI Ex. 63 (Mercer) at 9. Dr. Mercer asserts that this assumption is conservative because it tends to overestimate costs by assuming a maximum dispersion of customers located in any given census block. DPS and OAG witnesses agreed. OAG Ex. 110 (Morrisette) at 9-10; Tr. 514-16, 956-57.

57. Once all customer locations are established by either geocoded data or by the surrogate location methodology, the PNR preprocessing module groups customers into clusters. The only restriction on the location of clusters is that they cannot cross a wire center boundary. They can, however, cross census block boundaries. Tr. 560. The clustering algorithm groups customers together within certain constraints. No customer location may be more than 18,000 feet from the centroid of the cluster, clusters may not contain more than 1800 lines, no customer location may be more than two miles from its nearest neighbor in the cluster. AT&T/MCI Ex. 65, RAM 15 (Mercer 1/30/98) at 31. To perform efficient clustering calculations, all customer locations are assumed to be at the center of 150 square foot cells. The clustering algorithm takes a cell and searches for neighboring cells containing customer locations. If a neighboring cell is populated, the algorithm determines whether any of the cluster constraints would be violated by adding the cell to the cluster. If not, the cell is added to the cluster and the search process is repeated. Once this process is completed, the algorithm runs again, but checks for populated neighboring cells within a two-cell distance from the initial cell. The algorithm continues to run, enlarging its search range each time, until no more cells can be added

to the cluster without violating one of the constraints. AT&T/MCI Ex. 65, RAM 15 (Mercer 1/30/98) at 32.

58. The next step in the preprocessing involves chaining outlier clusters (those with four or fewer customers) to main clusters (those with more than four customers) so as to minimize the length of the chains. In addition, the algorithm "rectangularizes" each cluster about its centroid so that it has the same area, centroid, and aspect ratio as the convex hull of the cluster. Each rectangle is then rotated to a north-south alignment. AT&T/MCI Ex. 65, RAM 15 (Mercer 1/30/98) at 33.

59. The results of the preprocessing are then passed to HAI and included in an inputs database for the HM in a table named ClusterData. The table contains an entry for every rectangular cluster in the country and each entry contains data about the cluster's size, location, wire center, census block group, and line counts, among other information. No data regarding the locations of individual customers is passed to HAI or included in the HM.

60. The HM then designs distribution plant to the customers in each cluster in every wire center in the service area of the ILEC being studied. The HM assumes that the number of customers identified for each cluster during preprocessing are uniformly distributed throughout each cluster and designs distribution plant generally in a rectilinear design. It does not design distribution plant to actual customer locations or make placements along existing roads or otherwise consider geographic barriers (except as the wire center boundaries reflect such barriers).

61. Dr. Emmerson filed maps of three sparsely populated wire centers in Minnesota showing wire center boundaries, census block boundaries, and geocoded customer locations. The wire centers are Mahnomen, Warroad, and Gibbon. USW Ex. 8, RDE 1-3. These three exhibits confirm that geocoding in rural areas in Minnesota is only available in towns, where people have street addresses. The map of the Gibbon wire center (RDE-3) also shows satellite observations of customer locations. Mr. Klick testified that satellite photos "locate something less than half of the customers that the census data says are in the wire center. . . ." Tr. 899. Dr. Emmerson filed two additional maps of the Gibbon wire center, RDE-4 adding the HM rectangular clusters and RDE-5 adding the BCPM ultimate grids. Even though U S WEST has sold the Gibbon wire center, RDE-4 is helpful as an illustration of how the HM rectangular clusters represent the customers in the wire center. While the clusters do not cover every actual customer location, they are quite large and cover most of the area of the wire center. It can be assumed that for every actual location not covered by a cluster, there is roughly one extra proxy customer within the nearest cluster. As Dr. Mercer explained it, "… those customers did have their influence on where the cluster's located and how big it is." Tr. 569-70. Because the clusters are so large and because the model assumes the customers are evenly dispersed throughout each cluster, the clusters appear to approximate quite accurately the even dispersal of customer locations throughout this farming area of Sibley County shown by the satellite observations.

62. Mr. Klick filed additional maps of the three wire centers with additional information helpful to the issues here. Exs. 156-58. The first pages of the exhibits show that census block boundaries very often follow roads, and occasionally rivers and political boundaries, confirming Dr. Mercer's observations. It also confirms the reasonableness of the HM's methodology of distributing ungeocoded customers along the periphery of their census blocks. As DPS argues, since the BCPM assumes all customers are distributed along roadways, not just those customers who are not geocoded, it is difficult to see how the HM's surrogate location methodology is appreciably better or worse because both models make similar assumptions. U S WEST witness Dr. Emmerson concedes this point: "It is our opinion that given that one cannot geocode these households that it doesn't matter, that it's just as well to assume that these households in the census block are distributed along the roadways as it is to assume they're distributed on the periphery of the census block or any other assumption." Tr. 65. DPS Brief at 30-31.

63. The maps also help illustrate that the claim that the HM's placement around the periphery is "conservative" is not necessarily correct. Looking at one census block, the claim seems correct because the customers are spread out to the maximum extent possible. However, as Dr. Emmerson pointed out, every census block is surrounded by other census blocks that likely have a similar number of ungeocoded customers on their peripheries. Thus, there is some concentration along the peripheries and the placement is not conservative at all. Moreover, the maps illustrate that the rectangular clusters created for even these sparsely populated wire centers often encompass several census blocks, so the specific location of customers within the census blocks is often irrelevant. If the HM's method leads to designing too much distribution plant at all, the amount is minimal. It cannot be concluded that the HM overbuilds plant.

64. The second and third pages of Exs. 156-158 show the BCPM's road-reduced distribution areas. They illustrate how the BCPM must design distribution to a greater number of smaller distribution areas. By limiting the maximum size of a carrier serving area to 12,000 by 14,000 feet and the maximum number of lines served in a carrier serving area to 1,000 lines, the BCPM significantly overstates costs. Both of these limitations are “artificial,” in the sense that they are not dictated by limitations in existing technology. AT&T/MCI Ex. 70 (Fassett 11/24/97) at 5-10. The effect of these artificial limitations is to increase the number of DLC terminals that must be placed. BCPM places approximately 70 percent more DLCs than does the HM to serve the same number of customers. AT&T/MCI Ex. 80 (Klick 1/23/98) at 30-34. Because DLC terminal equipment is expensive, BCPM’s overstatement of the number of terminals required inflates costs. AT&T/MCI Ex. 81, Ex. JCK-10 (1/23/98) at 17-19.

65. The OAG argues that the maps show an example of overbuilding by the HM as well. For example, in Ex. 156, the Warroad wire center, it can be seen that the HM models a cluster in the northwest corner and one in the southeast corner where the BCPM does not, and where there are no roads shown. The OAG implies these are unneeded clusters. There are at least two defects in this argument. First, Dr. Emmerson's map, Ex. 8, RDE-2, shows the census blocks in those areas are not unoccupied, so there is somebody there. Second, the number of customer locations in

those clusters is unknown because those numbers are not shown on the maps. An examination of the ClusterData table shows there are two outlier clusters modeled in the Warroad wire center that each have only one line; they may be these two clusters. There is no reason to conclude that the HM has overbuilt this wire center or overbuilds in general. All the credible evidence is that the HM builds a very efficient network.

66. MCI and AT&T argue that BCPM's customer location methodology is flawed because there is not sufficient information to disaggregate census data below the census block level. They note that the Rural Utilities Service expressed support for the use of geocoding data as the most accurate method for locating customers. In the absence of geocoding data, the Rural Utilities Service has commented that CBs should be the geographical unit used to represent rural households because they are the highest level of census resolution, any higher level would be extrapolations from CB information, and CBs are small enough that errors in calculating the cost to serve will be significantly reduced in most cases. AT&T/MCI Ex. 80 (Klick 1/23/98) at 27-30. The ALJ disagrees; extrapolating data from larger to smaller units is a common, necessary, and legitimate modeling technique used in both the BCPM and HM. The question is whether the particular extrapolation is appropriate under the circumstances and how well it epitomizes reality.

67. MCI and AT&T argue the BCPM uses inaccurate assumptions to perform the disaggregation of population data to the grids. The BCPM assigns census data to a grid based upon the percentage of the road network in the census block that is located in that grid. USW Ex. 17, PBC-4 at 26; Tr. 23. MCI and AT&T argue that BCPM does not distinguish between roads that are deserted or sparsely populated and those that are densely populated and that the TIGER database that BCPM uses to determine the road network is three years old. MCI/AT&T Brief at 8-9.

68. The ALJ finds that assigning population in proportion to the percentage of the road network is a reasonable construct because common knowledge, confirmed by Dr. Emmerson, indicates that where there are more roads, there are more people. It probably could be improved by adding a consideration for road type and use of more recent road data, but this is a model and there are reasonable limits to the amount of detail required.

69. A more significant problem is that the grid system that BCPM uses in designing distribution areas has the effect of breaking up clusters of customers that could be served as a group. This is because that grid system is driven by lines of longitude and latitude rather than by principles of efficient design. Thus, BCPM would serve a hypothetical group of four adjacent households very differently depending on where those households happen to be situated in relation to the arbitrary gridlines that BCPM imposes. If entirely included in one grid, all households in the group might be assigned to a single Carrier Serving Area served by a single DLC terminal and a single placement of subfeeder cable. If, however, the same group of households "straddles" the BCPM gridlines, that group would be assigned to as many as four different CSAs, requiring four DLC terminals and four subfeeder placements. Such an anomalous result does not reflect the efficient, forward-looking design required by the FCC. AT&T/MCI Ex. 80,

(Klick 1/23/98) at 20 29; AT&T/MCI Ex. 81 (JCK-10) at 19-21; DPS Ex. 112 (Legursky 1/23/98) at 10.

70. Dr. Emmerson testified that the geocoded information utilized in the HM preprocessing is not reliable because an insufficient percentage of customer locations in rural, high cost areas are geocoded. He would not consider geocoded information reliable until 60 to 80% of customer locations in rural areas were geocoded. Tr. 31. The Department's position is that correctly locating customers is critical to accurately estimating the costs of serving them and all other things being equal, a model which makes use of geocoded customer location information is superior to a model which relies on customer location data at the CB level. DPS Brief at 26-27.

71. Mr. Legursky testified that he judged the HM "superior" or "clearly superior" in using geocoded information to locate population clusters. He further stated that the HM's geo-locating process is the closest approximation to actual customer cluster locations that he has seen. The HM's superiority over the BCPM in this regard was a major factor in his recommendation that the HM be selected for estimating Universal Service costs in Minnesota. Tr. 953, 1022-23.

72. The ALJ finds that the HM is better than the BCPM in its customer location methodology, customer clustering algorithm, and design of efficient distribution areas. The HM's creation of realistic customer clusters is logical and the clusters accurately represent actual customer locations. The road-reduced quadrants of the BCPM are less realistic representations of actual customer locations. Earlier versions of the Hatfield Model were criticized because they did not design plant to carrier serving areas the way network designers actually do. Now the HM's design methodology is more consistent with the way telecommunications networks are actually designed than the BCPM's.

Description of Network Technology

73. BCPM includes current generation digital switching at current network switch nodes, fiber driven digital loop carrier, and efficient copper/fiber crossover points in feeder to reflect the least-cost provision of feeder. USW Ex. 1, (Emmerson 11/24/97) at 6-7. The BCPM also includes SONET ring transport based on actual homing relationships and SS7 signaling. USW Ex. 25 (Copeland 1/19/98) at 4-6. The BCPM places host, remote or stand-alone switch types, depending on the current designation of the switch at the location. USW Ex. 28 (Copeland 2/3/98) at 14. In ¶124,of the FNPRM, the FCC tentatively concluded that the model should place more than one switch at a location, when the mechanism predicts that one of a set of capacity constraints would be exceeded. BCPM meets this requirement. The BCPM can scan the input table to determine whether the capacity constraints for any given wire center have been exceeded. If these constraints are exceeded, the model automatically inserts a new switch entity. USW Ex. 25 (Copeland 1/19/98) at 4.

74. The HM reflects the use of modern technology, including DLC systems on fiber in the feeder plant, digital switching, fiber rings for interoffice transport, and SS7. The

HM analyzes the cost of alternative placement methods and cable types in arriving at a least-cost solution. AT&T/MCI Ex. 59 (Mercer 12/17/97) at 15.

Use of fiber or copper and electronics, gauge of copper

75. Telephone signals can be transmitted over either fiber or copper. Signal strength attenuates over very long copper loops in the 12,000-18,000 foot range and while this can be compensated for by deploying load coils, digital services like ISDN cannot be provided over loops with load coils. Signal strength does not attenuate over similar distances of fiber. Fiber and its associated electronics have different costs than copper cable. Thus, in addition to the technical limitation on the length of copper in the loop, there is a point in the loop at which economic considerations dictate the use of fiber over copper. The FCC has tentatively concluded for technical reasons that the maximum length of copper in the loop should be 18,000 feet. FNPRM, ¶ 87. The FCC also tentatively concluded that loading coils should not be used and that the preferred model should adopt the BCPM approach of deploying fiber to avoid loading coils. FNPRM, ¶ 87. Neither model generally permits loops to consist of more than 18,000 feet of copper. Both models permit users to select the distance at which fiber is more economically deployed than copper. DPS Ex. 112 (Legursky 1/23/98) at 20.

76. The BCPM places copper if the maximum loop length from the wire center to all customers in the ultimate grid is less than twelve kilofeet. The BCPM places fiber in the feeder if the loop length for any customer in the ultimate grid exceeds twelve kilofeet and uses extended range plug-ins to service very long copper loops. For all loops, cable beyond the digital loop carrier site is copper. 26-gauge cable is used in the feeder and 26/24 gauge is used in distribution. USW Ex. 26, Ex. PBC-4 at 40.

77. The HM does not deploy load coils. Instead, it relies on copper T1 to serve customers with loops longer than 18,000 feet. For loops slightly less than 18,000 feet, that is those between 17,600 and 18,000 feet, the HM should deploy an extended card such as the RUVG2 card, but does not. Tr. 542. However, the card costs that HM models are a composite of the POTS card and the RUVG2 card. Since only 2% of copper loops are very long, the costs of the more expensive cards are covered adequately in the HM cost estimates. Tr. 626-27; 721-22; AT&T/MCI Ex. 72 (Fassett 2/3/98); DPS Ex. 112 (Legursky 1/23/98).

78. U S WEST claims that the HM's long loops will provide inadequate service. However, Mr. Fassett testified that the HM assumes the use of “extended range cards” and 24-gauge cable that will permit service at lengths of up to 18,000 feet without impeding the provisioning of advanced services. Mr. Legursky testified that a forward-looking network would not deploy T1 cables in the loop but would instead use extended range plug-ins. He urged the HM modelers to substitute fiber extensions for copper T1s. However, Mr. Legursky also testified that "it is not wrong or inadequate in any way to use T1 extensions to serve very long loops." Tr. 954. Consequently, the Department is not advocating, at this point, that the Commission order the HM sponsors to change their long loop design. DPS Brief at 42-43. DPS Brief at 43.

79. Based upon Mr. Legursky's opinion that the HM's use of T1 technology is marginally acceptable, the ALJ finds that the HM complies with the requirements of ¶ 250(1).

80. Mr. Schaaf claimed that the HM uses “nonstandard and untested technology” because of the HM’s use of the new “GR-303” digital technology. However, Mr. Schaaf acknowledged that that technology had been tested recently for compatibility with Lucent switches and that a production version of the technology was scheduled to be available in the fourth quarter of 1997.

Design of feeder and distribution paths

81. The BCPM employs a multi-step process to design feeder described in the BCPM Model Methodology, USW Ex 26, Ex. PBC-4, at 35-44. Very generally, a maximum of four routes runs north, south, east and west for ten kilofeet from the central office, then a decision is made whether to angle or split the feeder, based on population concentrations and a least cost calculation. Subfeeder branches from the main feeder are made as required, sometimes being steered directly to SAIs. The BCPM designs plant to connect customers based on the assumption of equal square-sized lots within square distribution areas whose total area is equal to the length of roads in the populated microgrids in the quadrant of the ultimate grid, times one thousand feet. The HM uses a roughly similar process described in HM Model Description § 6.4, AT&T/MCI Ex. 65, Ex. RAM-15. One difference is that all branches are at right angles.

82. Mr. Fasset notes that the shortest distance for a sub-feeder back to a feeder is at a right angle. He asserts that while the BCPM methodology may result in lower average loop lengths, the multiple feeder cables the BCPM designs increase structure costs. AT&T Ex. 67 (Fassett 11/24/97) at 11-12. Mr. Morrisette testified that feeder cost in the BCPM as a percentage of the total loop cost is significantly higher than in the HM or U S WEST’s RLCAP. OAG Ex. 110 (Morrisette 1/23/98) at 8. The ALJ finds that the BCPM path design methodology again tends to increase costs.

Plant mix decisions (aerial, underground, buried)

83. Both models allow the user to input structure mix percentages. However, in determining the appropriate structure mix, the FCC's scorched node assumption provides no assistance because several interpretations are possible. If electric companies' utility poles remain in place after scorching, there would be a great incentive to hang cables from them. While communities might find new aerial placement unsightly, placing another wire on existing poles might be better than having all their streets torn up to place cable underground. If scorched node means there are no poles, the community might prohibit aerial placement. The parties take the predictable positions. The HM proponents argue that we should look at existing mix percentages, which is more aerial placement. The BCPM proponents argue that aerial placement is currently low and "looking forward", will get lower because it has now been recognized that underground and buried cable have lower maintenance cost in the long run. The

HM's default values reflect the lower cost use of more aerial; the BCPM's reflect the higher cost use of more underground and buried.

84. The HM assumes that the minimum aerial will be twenty five percent in the least dense zone, and that the range will go up to eighty-five percent in the most dense zone. Dr. Fitzsimmons testified that is unreasonable in light of the most recent data showing U S WEST having only 7.7 percent of its cable as aerial and the proportion declining from the previous year. USW Ex. 45 at 33. Mr. Legursky testified that the HM proponents advocate too high a percentage of aerial placement because local governments are increasingly prohibiting the aerial placement for aesthetic and safety reasons. DPS Ex. 113 (Legursky 2/3/98) at 12.

85. The Department offers a very reasonable proposal. It suggests that the placement mix issue be analyzed in light of the FCC's policy goals for Universal Service. The FCC seeks to establish support levels based on costs in such a way that carriers' decisions about facilities investments are based on real economic costs. Further, the FCC does not want inefficient carriers to have their inefficiencies subsidized by Universal Service support. Rather, support should be set at a level that preserves their incentive to operate and invest in economically efficient ways.

86. Dr. Fagerlund's opinion is that the most reasonable way to set placement mix percentages is to adopt the current placement mix percentages of an efficient carrier operating in Minnesota. DPS Ex. 115 (Fagerlund 1/23/98). The best evidence of the current placement mix of an efficient carrier filed in this proceeding is a report from U S WEST giving its placement mix in 1996, which is reproduced as Table 1 below. Tr. 294; Ex. 128 WLF-2 (Fitzsimmons 2/6/98). While U S WEST's placement mix is not necessarily identical to the mix an efficient, forward-looking competitive firm would experience today, it is a starting point for a realistic measure that is consistent with the FCC's policy goals. DPS Ex. 113 (Legursky 2/3/98) at 12-13.

Table 1
(DPS Ex. 113 (Legursky 2/3/98) at 12)

Placement Type	Sheath Miles	Percent of Total
Aerial	4,875	8.4
Underground	5,466	9.4
Buried	47,723	82.2
Totals	58,064	100.0

87. These percentages cannot be directly input into the HM because placement percentages vary by density zone. Mr. Legursky used the HAI Investment Input Worksheet to determine the percentage of distribution cable in each density group. Mr. Legursky then produced a table setting the structure mix percentage for each density group in such a way that when those percentages are applied to the each

density group's distribution cable amount, the resulting weighted averages for the percent of distribution cable by structure type matches U S WEST's recent structure placement percentages. His recommended input values for the percentage of placement by density zone and placement type are given in Table 2 below.

Table 2
(DPS Ex. 113 (Legursky 2/3/98) at 14)

Density	Aerial %	Buried %	Underground %
0-5	18.0	78.0	4.0
6-100	14.0	80.0	6.0
101-200	9.0	81.0	10.0
201-650	5.0	84.0	11.0
651-850	3.0	85.0	12.0
851-2550	2.0	85.0	13.0
2551-5000	1.0	85.0	14.0
5001-10,000	1.0	84.0	15.0
10,000+	0.0	84.0	16.0

88. The ALJ finds that the foregoing structure mix should be used for the cost study. If the HM is used, its structure shifting feature that, under certain conditions, changes the user specified structure mix and shifts plant from buried to aerial, must be disabled.

Incorporation of wireless technology

89. The FCC has recognized that in certain cases, supported services may be provided by wireless technology at a lower cost than they could be provided by wireline technology. Accordingly, the FCC has concluded that, to the extent practical, the selected model should estimate the cost of providing the supported services using wireless technology in areas where such technology is likely to be the least cost and most efficient technology. FNPRM, ¶¶ 91, 101. Both models can support such an algorithm.

90. The BCPM does not explicitly include wireless technology. However, it enables a user adjustable “cap” which U S WEST set at $15,000 for the runs in this proceeding, to be placed on the investment in loops. That cap could be used to reflect the availability of technology such as wireless that would become economical at a certain level. Tr. 171 (Copeland).

91. The HM includes a wireless cap that may be enabled by the user with adjustable caps. If enabled, it evaluates two wireless systems: a point-to-point with a cap per line

and a broadcast system with common and per line caps. The model compare the cost of the two wireless systems then compares the lower to the wireline cost. If the wireless cost is lower, it is substituted for the cost of the wireline distribution components. Tr. 518-21; HM Model Description § 6.3.4, AT&T/MCI Ex. 65, RAM-15. The defaults are $7500 per line for the point-to-point and $112,500 plus $500 per line for the broadcast. HM Inputs Portfolio § 2.11, AT&T/MCI Ex. 65, RAM-16.

92. Dr. Mercer, who does work on wireless systems, believes there is no good evidence yet on the cost of wireless systems. Tr. 518-519. There is no other evidence on wireless costs in this record. For that reason, the OAG recommends that the wireless cap not be enabled. The Department, nonetheless, recommends enabling the cap and setting its value at $7,500. DPS Brief at 45. Apparently they would also recommend the broadcast defaults as well.

93. The ALJ finds that there is no basis in the record for enabling the cap in either model at this time.

Use of host-remote switching

94. Switches may be classified as stand-alone, host, or remote. Remote switches are generally less expensive than stand-alone switches but must operate in conjunction with a host switch. Under certain conditions, it may be more cost effective to locate remote and host switches than to use a stand-alone switch at every location. FNPRM, ¶ 122. The FCC has tentatively concluded that the selected model should include an algorithm that places host switches in certain wire centers and remote switches in others. Id. Both models allow users to manually designate certain wire centers as remote locations. Neither model performs any cost minimizing algorithms to determine whether any given wire center should have a stand-alone, host, or remote switch. DPS Ex. 112 (Legursky 1/23/98) at 22-23. Thus, both models fall short in meeting this criterion.

95. The default data for the HM does not contain any host or remote switches. The BCPM default data did include host and remote switches. The BCPM defaults, however, simply take existing host and remote switch locations from the Bellcore Local Exchange Routing Guide (LERG). U S WEST witness Mr. Copeland testified that using the LERG data was consistent with TELRIC principles. Tr. 165; USW Ex. 28 Copeland (2/3/98) at 13-14. Further, BCPM not only places switches at their existing locations, it will only place the same switch from the same manufacturer as is currently in place. The rationale offered by U S WEST witness Mr. Copeland for this modeling decision is that "[w]hen you are putting in a switch you have to look at the other equipment there, and that's the reason that in the model we went with the current manufacturer so we wouldn't have an incompatibility problem, say, between a host and remote, or between other interface devices and the switch." Tr. 161. Assuming embedded equipment and technology may handily resolve incompatibility problems, but there is no reason to believe the assumption results in least cost, efficient switching costs.

96. DPS witness Legursky testified that the configuration of switches in the LERG data did not represent an optimal network configuration. He stated: ". . . the current host/remote locations represented by the LERG evolved over the last two decades, not over a single point in time. Budget constraints drove those decisions, technology has changed. I'm sure that if asked, a GTE engineer or a U S WEST engineer, or for that matter any network planner engineer could point to at least one location in the current LERG where the costs could be lowered or changed with an alternate configuration." Tr. 955. Mr. Legursky further testified that the host/remote deployments made today are driven by decisions that were made years, even decades, earlier. Tr. 1032. Those decisions thus reflected then current state of technology, the network as it existed then (composed of various vintages of equipment all of which was put in place in earlier years in response to then current conditions), then existing traffic patterns and volumes, as well as then current expectations of what the future would bring, expectations that may well not have been realized. *See also* AT&T/MCI Ex. 80, (Klick 1/23/98) at 15 and n.20.

97. The ALJ finds that the BCPM's use of existing switch design is not consistent with what an efficient carrier would put in place today and tend to overstate costs.

98. The FCC tentatively concluded that the recommended model should assign more than one switch to a wire center whenever it predicts that any one of a set of capacity constraints would be exceeded. FNPRM, ¶ 124. Both models meet this criterion. DPS Ex. 112 (Legursky 1/23/98) at 23.

Use of wire centers as center of loop network

99. Both models use existing central office locations as the starting point of loop design as required by the FCC.

Advanced services not impeded

100. The issue of the provision of advanced services relates to the fiber-copper crossover issue discussed above. The BCPM builds a higher quality network that is clearly capable of supporting 28.8 kbps modems. The HM's use of long copper loops up to eighteen kilofeet may not do so as reliably. The BCPM's network is more costly than the HM's in part because of this design difference. In Dr. Mercer's opinion, the HM designed network, as modeled, provides access to advanced services. AT&T/MCI Ex. 59 (Mercer 12/17/97) at 5, n.2. As previously concluded, the HM's design is adequate. Its performance does not impede access to advanced services.

Measurement of distances

101. The BCPM uses road distances to identify road centroids and the percentage of customers in CBGs larger than .25 square mile, who are located in specific microgrids. The BCPM uses road distances to locate the road centroids of ultimate grids and distribution quadrants. It uses road distances to size the distribution area, by multiplying such road distances in populated microgrids in a quadrant of an ultimate grid, by one thousand feet. USW Ex. 26, PBC-4 at 30-31. Once customer locations and distribution

areas have been established, plant is built using rectilinear distances, except where feeder is angled, in which case distance along the feeder and subfeeder would be airline. Tr. 190-192. The HM uses rectilinear distance for all routing, except when the user invokes "feeder steering." HM Model Description §§ 6.2, 6.3.6, AT&T/MCI Ex. 65, RAM-15.

102. According to U S WEST, an advantage of the BCPM method is that the intelligence on actual customer locations and potential telephone network facilities locations, which is contained in the geographic locations of the road network, is maintained throughout the process to guide the placement of facilities, just as would be done in practice by a telephone plant engineer. USW Ex. 26, Ex. PBC-4 at 33. However, the HM's computation of "rectilinear" distances when determining distribution and feeder distances is a "conservative" approach that takes into account variations from straight lines between points. Using that technique for estimating loop lengths makes it unnecessary to trace the road layouts. One would assume that following actual roads or other utility easements to actual customer locations would provided more accurate loop lengths, but the BCPM's road-reduced quadrants are not at actual customer locations, so it should not make much difference in this case. The ALJ finds no substantial difference between the models in determining distances.

Drop lengths

103. Drops connect the network interface device at the customer premise to the block terminal or pedestal. DPS Ex. 113 (Legursky 2/3/98) at 5. The FCC tentatively concluded that the selected model should determine the forward-looking economic cost of drops, including installation, terminal splice, and pedestal costs. FNPRM, ¶ 75. Both the HM and BCPM meet this requirement. *See, e.g.*, DPS Ex. 113 (Legursky 2/3/98) at 17. Consistent with the FCC's guidance, both models allow drops to vary by density zone and terrain type.

104. A significant factor in estimating drop costs is the length of the drop itself. While both models accommodate input values for drop length that vary by density zone, the default values for the two models differ substantially. The HM sponsors' decision to count special access lines on a circuit-equivalent basis and then to multiply the default drop length by the number of lines per density group may skew the resulting state-wide average drop length measure. Mr. Legursky recommended that the average drop length in the HM be calculated as the weighted average drop length using the BCPM line counts (which count special access lines on a pair-equivalent basis). The weighted average drop length is computed by multiplying the default drop length in each density group by the percentage of lines in that density group and summing the results. Using this method, Mr. Legursky calculated that the HM assumed an average drop length of 74 feet. DPS Ex. 113 (Legursky 2/3/98) at 5. Mr. Schmidt, a U S WEST witness, testified that the default drop lengths in the HM are too short and Mr. Legursky concurred. DPS Ex. 113 (Legursky 2/3/98) at 5. Mr. Schmidt testified that the average drop length for all U S WEST customers was 181 feet. USW Ex. 49 (Schmidt 11/24/97) at 3. He based that measurement on some 2,500 drop length estimates reported by

U S WEST personnel when visiting a residence to repair or install equipment. Tr. 212-13.

105. Mr. Legursky testified that he was influenced in his judgment as to the correct average drop lengths by Mr. Schmidt's testimony but that he took those numbers with a "grain of salt." Tr. 981. Mr. Legursky was concerned that Mr. Schmidt's measurements were not a random sample of drop measurements. Tr. 984. Mr. Legursky also thought that the 866 foot average drop length U S WEST reported for density group 5 was possibly due to the fact that longer drops are more subject to problems that would generate service calls and that service calls in very rural areas are more likely to be for repair than installation. Tr. 1053-54. Mr. Schmidt's figures did not correspond with the length Mr. Legursky thought would be reasonable based upon his own experience. Mr. Legursky reflected on his knowledge of where housing units tend to be in relation to roads and cables in very rural areas. He testified that from his experience he believed 250 feet was a reasonable average loop length for the least dense areas. Tr. 1052. Mr. Legursky calculated the correct weighted average drop length to be 109 feet, an increase of 47% over the HM default value. Mr. Legursky's recommended drop length by density zone is given in Table 3.

Table 3
(DPS Ex. 113 (Legursky 2/3/98) at 6)

Density Group	HAI 5.0 Default	Recommended Value
0-5	150	250
6-100	150	200
101-200	100	150
201-600	100	125
601-800	50	110
801-2550	50	90
2551-5000	50	80
5001-10,000	50	70
10,000+	50	50

106. Dr. Fitzsimmons also adjusted the HM's input for drop length using the BCPM density specific drop lengths, which produced and average of 129 feet. (Ex. 45, p. 32) Dr. Fitzsimmons calculated that using the BCPM density zone specific drop lengths, would increase the cost of Universal Service by $.50 compared to the HM defaults. USW Ex. 45 (Fitzsimmons 1/23/98) at 32.

107. The ALJ finds that the HM drop length defaults are too low, but also that the basis for Mr. Legursky's adjustments to the U S WEST study figures is inadequate.

While there may be flaws in U S WEST's sampling technique, it appears to be more sound than Mr. Legursky's general impressions and "line smoothing" approximations of drop lengths. The U S WEST figures as proposed by Dr. Fitzsimmons should be used instead of the HM defaults.

Closing to actual wire center counts

108. A significant defect in the HM methodology is that it does not place the correct number of customers in the correct wire centers for a significant number of customers in Minnesota. At ¶ 53 of the FNPRM, the FCC emphasized the importance of accurate line counts by wire center or smaller geographical units. Dr. Fitzsimmons testified that the HM errs in residential line placements by twenty percent or more in fourteen of U S WEST's one hundred fifty three wire centers in Minnesota, and by fifty percent or more for business lines in thirty seven of these wire centers. USW Ex. 43 (Fitzsimmons 11/24/97) at 8. As U S WEST argues, this error can affect all subsequent calculations because the erroneous association of customers with wire centers will create spurious economies of scale in some wire centers and cause false losses of economies in others. USW Brief at 24-25.

109. U S WEST argues that "Dr. Mercer testified that he did not even attempt to ensure that the HM produced accurate line counts by wire center, even though he possessed the information necessary to do this and it is a specific requirement of the FCC's order." USW Brief at 24-25. This argument is very misleading. Dr. Mercer testified that the PNR preprocessing could normalize line counts at the CB level using actual wire center counts if that data was available. U S WEST's attorney asked him if he was aware that the U S WEST wire center line counts were available in the BCPM inputs. Dr. Mercer said that he was not and had not looked for the data there because he assumed that the data was proprietary. That is a legitimate assumption because the ILECs have historically claimed such data was proprietary and because the BCPM sponsors made no particular announcement that they were including U S WEST's wire center line counts in the BCPM inputs. The counts first appeared in the BCPM version filed January 20, 1998, (USW Ex. 27), in a file called lines.csv. But, that file does not contain field headings, which is an option with "comma separated value" (csv) files, so its very difficult to tell what data the file contains. U S WEST's argument is also misleading because it implies that the BCPM is better than the HM in normalizing to wire center line counts. The BCPM can do such normalization, if it has the data. However, the filed version only has the data for U S WEST and not for the other ILECs. The HM's preprocessing program can be modified to do that normalization as well, if it has the data. The problem is with the ILECs not providing the data.

110. Dr. Mercer also testified that normalizing to wire center counts would be unlikely to change the HM results much because the adjustments using the company counts were so small and he would not expect any different result. Tr. 353-6. However, the ALJ agrees with U S WEST, the DPS, and the OAG, as well as the FCC, that such normalization should be required, particularly to increase the accuracy of determining demand in the least populated areas.

111. As a corollary point, the Department wants to ensure that service areas are accurate. Accordingly, the Department maintains that wire centers sold by U S WEST effective in September, 1997 should not be included in the U S WEST data base. DPS Ex. 115, EF 1 (1/23/98) at 15; DPS Ex. 116, EF 1-2 (2/3/98) at 4. This will have the effect of reducing cost estimates since the sold exchanges are rural, high cost exchanges. USW Ex. 46, WLF-2 Table A (Fitzsimmons 1/23/98) (Exclusion of sold exchanges reduces loop cost estimate by $.88). In addition, the six Minnesota exchanges formerly owned by GTE North should be consolidated with the former Contel exchanges because all these exchanges were merged in 1991 DPS Brief at 15.

112. DPS urges that the costs involved in testing, quickly replacing defective lines, permitting dedicated idle capacity, and responding rapidly to requests for new and additional service(s) by customers and CLECs should be modeled. DPS Ex. 115, EF 1 (1/23/98) at 14-15. For the HM, the testimony of Dr. Mercer indicated that whether dedicated idle lines were included in the network model depended on how U S WEST and other companies reported working lines. Dedicated idle might, or might not, be included in their counts of working lines. If such lines were not included in the count, some changes would have to be made to the algorithms of the model. Tr. 549-51. The ALJ agrees.

Comparison to actual average loop length

113. While both models produce average loop length figures, no information on the ILECs' actual average loop lengths was placed into evidence in this proceeding. DPS Ex. 115 (Fagerlund 1/23/98) at 27-29; Tr. 954. Neither model performs any sort of normalization to actual average loop lengths.

114. As U S WEST states, the debate over the relative accuracy of models in determining locations of customers is really a debate about the accuracy of the models' portrayals of loop lengths. USW Brief at 19. That is not to say, however, that loop lengths should equal existing actual average loop lengths, because existing loop layouts are probably not the most efficient. As the OAG suggests, that would be akin to using embedded costs. OAG Brief at 15-16. Moreover, it is sometimes more efficient to run some distribution lines along the same poles or other structure for some distance rather than run each line directly to the individual customers because of the savings in structure and placement costs. For this and other similar design reasons, average loop lengths are not necessarily indicative of the most efficient design. The ALJ concludes that the failure of the models to report a comparison to actual average loop length as required by ¶ 250(1) is not significant.

All Functions and Elements Costed

115. Universal Service Order ¶ 250(2) states: "Any network function or element, such as loop, switching, transport, or signaling, necessary to produce supported services must have an associated cost."

116. Both models include the associated cost of each network function or element used to provide the supported services and, therefore, both models satisfy this requirement. Mercer Dir. (Ex. 51) at 7-8, 14-15; Mercer Sec. Supp. Dir. (Ex. 59) at 13. Tr. 1033-35; RAM-15 (Ex. 65) at 3-4. (Ex. 16, p. 10; Ex. 25, pp. 5-6 (Copeland)). DPS Brief at 13; OAG Brief at 23.

Only Long-Run Forward-Looking Economic Costs Included

117. Universal Service Order ¶ 250(3) states: Only long-run forward-looking economic cost may be included. The long-run period used must be a period long enough that all costs may be treated as variable and avoidable. The costs must not be the embedded cost of the facilities, functions, or elements. The study or model, however, must be based upon an examination of the current cost of purchasing facilities and equipment, such as switches and digital loop carriers (rather than list prices).

118. In the Universal Service Order, the FCC adopted the recommendations of the Federal-State Joint Board on Universal Service that Universal Service support should be based upon forward-looking economic cost, as determined by a cost model. The recommendation was based upon findings that cost models provide an efficient method of determining forward-looking economic cost, the ability to determine costs at small geographic levels, and provide a competitively neutral estimate of the cost of providing the supported services, because they are not based on any individual company's costs.

Company specific inputs

119. GTE's position in this proceeding is that it is an efficient carrier and that the prices it pays for inputs should be used when estimating costs for its service territory Similarly, GTE asserts that its business practices are efficient and accordingly, the company's specific costs should be incorporated into cost estimates for its territory. In sum, GTE contends that it is entitled to recover its actual costs through Universal Service subsidies. The FCC explicitly rejected measuring Universal Service costs for non-rural carriers on the basis of each carrier's particular embedded costs, explaining that "[t]he use of embedded cost would discourage prudent investment planning because carriers could receive support for inefficient as well as efficient investments. The appropriate costing methodology must not be "based on any individual company's costs" in order to "provide a competitively neutral estimate of the cost of providing the supported services." Universal Service Order ¶ 232.

120. GTE asserts that "the total Universal Service support set by this Commission, together with Commission-established retail rates and UNE prices, must be sufficient to compensate GTE for all the costs GTE incurs in providing service in Minnesota. GTE Ex. 85 (Robinson 11/24/97) at 3. This assertion seeks to tie what should be a proceeding narrowly focused on an efficient carrier's costs into a proceeding that considers every company's costs and every company's revenue requirements. As explained above, Universal Service costs are the costs an efficient provider would incur today in providing the supported services. Universal service funds will only contribute to covering the costs of providing certain specific services and not all the costs of providing

all services. Because costs are to be the forward-looking economic costs of an efficient carrier, costs are not firm specific. Because federal Universal Service support will extend only to "25 percent of the difference between the forward-looking economic cost of providing the supported service and the appropriate revenue benchmark" and because the revenue benchmark is nation-wide, the entire universal support mechanism has nothing whatsoever to do with the particular costs or revenues of specific companies. Universal Service Order ¶ 201, 263.

121. The position GTE advocates would not encourage companies to provide supported services efficiently and, by subsidizing inefficient carriers, it could impede the development of competition. Further, it would be a departure from the TELRIC principles the Commission has adopted in the arbitration proceedings to determine unbundled network element costs. The FCC has warned of the arbitrage problems that would ensue if states developed unbundled network element prices on a different basis than Universal Service support costs and urged states to use the same criteria for both sets of costs. Universal Service Order ¶ 251.

122. GTE also argues that it has constitutional and statutory rights to just and reasonable compensation. Assuming that to be correct, it must be noted that the selected cost study will provide such compensation because setting Universal Service support based upon forward-looking economic cost is consistent with sound economic principles. In competitive markets, prices reflect the forward-looking, long run incremental cost of serving the market. AT&T/MCI Ex. 80 (Klick 1/23/98) at 6. Thus, care has been taken in this report to ensure that the HM inputs are not less than "least cost," and that the costs determined by the selected study provide just and reasonable compensation. That compensation is the reasonable value of the services being provided, not GTE's costs. There is no right to excessive compensation. If GTE truly is as efficient as it claims, it will receive more than adequate compensation.

Company size inputs

123. Frontier points out that the FCC has tentatively concluded that the costs used to determine Universal Service support payments should reflect the size of an applicant eligible telecommunications carrier, stating: “users should be able to use different expense estimates for small, medium, and large companies, as the BCPM allows.” FNPRM ¶ 157. Both models permit users to input different expense estimates, and those can be set to represent typical costs for small, medium, and large companies. DPS Ex. 115, EF 1 (1/23/98) at 41-42.

124. Frontier argues that the cost study selected here should be run using the methodology and the default values developed and approved by the MPUC in this proceeding, but that Frontier should have the opportunity to petition the MPUC at a subsequent time for a determination of the appropriate cost inputs for Frontier based on the forward-looking costs of an efficient company with similar characteristics. Frontier Brief at 4. No party objected to this proposal. DPS stated that it agreed In principle that where it can be demonstrated that efficient firms of different sizes have different costs, different input values reflecting those cost differences may be used, provided the

burden of establishing cost differences was be placed on the company claiming such differences exist. Tr. 1085, 1091-1092; DPS Brief at 50-51. The ALJ notes that since Frontier has offered no evidence in this proceeding (beyond obtaining general concurrence from Mr. Legursky with the presumption that smaller companies tend to pay more for everything than the larger companies whose costs are the ones being modeled here), there is no issue to be decided with regard to the cost study being selected for use by the FCC. The ALJ also notes that the HM does use a company size factor in the Switching and IO module to raise the switching investment curve for small companies by $173 per line. HM Model Description §§ 2.8.2. and 6.5.3.1, AT&T/MCI Ex. 65, (RAM-15). There do not appear to be any other adjustments for company size in the HM.

Cost Input development

125. The costs of materials and labor used by the HM reflect current market conditions as determined and verified by an engineering team with extensive background and experience in the design and construction of modern telephony networks. AT&T/MCI Ex. 51 (Mercer 10/24/97) at 19-20; *see generally* AT&T/MCI Ex 66 (Fassett 10/24/97). As part of that effort, Mr. Fassett surveyed a large number of vendors and contractors to determine current market prices of necessary equipment and materials. Ex. 66 at 9-10. In addition, Mr. Fassett traveled throughout Minnesota to observe existing conditions, particularly relating to placement type and the availability of sharing opportunities. Ex. 66 at 17-19. The process of confirming the reasonableness of inputs in the HM has been ongoing. AT&T/MCI Ex 69 (Fassett 12/17/97) at 2-6.

126. The BCPM contains U S WEST's current material and structure cost as inputs. USW Ex. 28 (Copeland 2/3/98) at 16. The BCPM is capable of accepting cost inputs for other companies that reflect those companies' specific costs of purchasing facilities and equipment. GTE has, in fact, submitted cost input evidence resulting from just such a process.

127. The process used by the BCPM modelers to determine inputs has been, in comparison to the HM, much less thorough. As observed by Mr. Morrisette, the BCPM sponsors admit that they have "devoted few, if any, resources to the refinement and documentation of the input factors to the model." OAG Ex. 109 (Morrisette11/24/97) at 7 n.3. Unlike the HM, which relies upon the collective judgment of an engineering team, the job of verifying the BCPM inputs fell to one man, Mr. Schaaf. Tr. 233. Mr. Schaaf testified that his review of the BCPM inputs was based primarily on the average of costs from proprietary survey responses from five companies: NYNEX, Bell South, US West, Pacific Bell, and Sprint. Tr. 233-34. Unlike the HM, which has continued to improve and refine input values as more information has become available over time, the BCPM inputs have remained essentially unchanged since version 1.1. Tr. 232.

128. The result of the processes used by the modelers produced predictable results. The HM inputs are lower, generally reflecting the least cost options available in the marketplace. The BCPM inputs are higher, reflecting the large ILECs' own reports of the costs they are required to pay.

Buried Placement Costs

129. The costs of placing cable underground are significant and include the costs of trenching, filling, and restoring the surface to its original condition. According to Mr. Legursky, the record does not support the selection of either model's default proposed costs for buried placement. Therefore, he advocates averaging the buried placement values of both models across the lowest seven density zones and using the BCPM values in the two highest density zones to avoid a major discontinuity in the rate at which costs increase with density. The resulting values and the more gradual rate of increase are consistent with Mr. Legursky's experience with such costs and how they should vary across density groups. DPS Ex. 113 (Legursky 2/3/98) at 9-10. Table 4 shows the Department's recommended values.

Table 4
(DPS Ex. 113 (Legursky 2/3/98) at 10)

Density Group	HAI 5.0	BCPM 3.1	Recommendation
0-5	1.77	1.47	1.62
6-100	1.77	1.82	1.80
101-200	1.77	4.46	3.12
201-600	1.93	5.74	3.84
601-800	2.17	8.26	5.22
801-2550	3.54	8.26	5.90
2551-5000	4.27	8.71	6.49
5001-10,000	13.00	9.47	9.47
10,000+	45.00	10.41	10.41

130. The ALJ finds that Mr. Legursky's recommendations are reasonable and should be adopted.

Structure Sharing

131. Structure sharing refers to the possibility that telephone companies may be able to share construction costs for placing outside plant with other companies. Utility poles may support power cables and CATV coaxial cable feeder in addition to telephone lines. Similarly, trenches can be dug wider or deeper, or larger conduits installed, to permit multiple parties to share costs. The FCC has tentatively concluded that the chosen model should permit sharing levels to vary according to installation activity, terrain conditions, and line density zones. FNPRM, ¶ 79. In July 1997, the FCC endorsed the BCPM's installation and terrain condition categories and the HM's line

density zones. Both models now permit sharing to vary by line density zone. DPS Ex. 113 (Legursky 2/3/98) at 17-18.

132. The FCC tentatively concluded that 100% of the costs of plowing in buried cable should be borne by the telephone company and that generally, 66% is an acceptable aggregate default value for the percentage of structure costs borne by the telephone company. FNPRM, ¶¶ 80-81. Both models permit users to vary sharing percentages, although the default value for plowed-cable submitted with the HM is not 100%. DPS Ex. 112 (Legursky 1/23/98) at 19. Neither model was submitted with aggregate default sharing values of 66%.

133. The structure sharing assumption has a significant impact on outside plant costs. The HM sponsors contend that an efficient carrier would aggressively seek out sharing opportunities and would need to absorb only 33% of structure costs. The BCPM sponsors assumed to the contrary that there would be little sharing in the scorched node context because only telephone facilities are "scorched." DPS Ex. 113 (Legursky 2/3/98) at 7. However, U S WEST witness Dr. Fitzsimmons testified that Mr. Legursky's recommended value was within the range of reasonableness. Tr. 280. Again, this parameter should be set at a value that approximates current practice. The decision on this issue should be based on what efficient forward-looking carriers are experiencing in the way of structure sharing today. Ex. 115 at 15 (Fagerlund 1/23/98). On this basis, Department contends the appropriate percentage of structure cost the telephone company should absorb in aggregate is 66%. DPS Ex. 113 (Legursky 2/3/98) at 8-9. This is the roughly the midpoint of the percentage range of sharing which Mr. Kaalberg, Network Service President of McLeod USA, testified to the Iowa Commission that his company was able to achieve as a result of its aggressive search for sharing opportunities. USW Ex. 45 (Fitzsimmons 1/23/98) at 25. It is also the sharing percentage recommended by Sprint and by the Federal-State Joint Board. FNPRM, ¶ 78. The ALJ agrees.

Labor Factor

134. Dr. Fagerlund recommends that a regional labor adjustment factor of .99 for Minnesota be used because labor costs in Minnesota are one percent less than the default level for labor costs in the HM. This factor adjusts the wage portion of facility installation costs. The Department used this factor in its HM runs. DPS Ex. 115, EF 1 (1/23/98) at 5. The ALJ agrees.

Switch costs

135. The FCC tentatively concluded that the selected model should incorporate its staff's estimates of switching costs, namely, a fixed cost of $185,374.00 and per-line cost of $107.00. It sought comment on that conclusion. FNPRM, ¶ 132.

136. Both models can use the FCC switch cost as inputs, but both use their own defaults. Mr. Legursky analyzed the HM and BCPM switching modules to determine whether either module produced results in line with his knowledge of actual switching

costs. Tr. 974. He concluded that the HM's results were "much better, but still conservative." Tr. 954.

137. Mr. Legursky acknowledged that the HM derived switch costs from a regression curve calculated from just four data points. Tr. 973. His concern however, was not with the derivation of the cost curve, but rather with whether the curve generated accurate cost estimates. He testified: "I have absolute confidence in the results that are produced by the regression curve." Tr. 975. Mr. Legursky described the results of the BCPM methodology as "terrible" and as "way out of line with current industry practice." Tr. 953-54. While he approved of the BCPM methodology for computing switch costs, Mr. Legursky noted that the methodology relied on proprietary information that for practical purposes is not reviewable. DPS Ex. 112 (Legursky 1/23/98) at 25. He also testified that ". . . one model may have a superior methodology and not produce a superior result. . . ." Tr. 1020.

138. Mr. Legursky is knowledgeable of actual switching costs through his familiarity with Ameritech's switch contracts, his knowledge of the switch contracts of other RBOCs, and because he reviewed U S WEST switch contracts in connection with his work for the Department. Tr. 954, 974. Based upon his opinion, the ALJ finds that the HM's switching curve should be used for determining switching costs, rather than the FCC staff numbers.

Interoffice Trunking, Signaling, And Local Tandem Investment

139. The FCC tentatively concluded that the selected model should calculate specific cost estimates for the interoffice elements (i.e. interoffice trunking, signaling and local tandem facilities). FNPRM, ¶ 141. Both models deploy SONET ring technology to connect stand-alone switches to tandems, to connect remote to host switches, and to connect host switches to tandems. Neither model employs an optimizing algorithm in creating SONET rings and neither stores intermediate data to detail specific locations, capacity, or utilization of rings. Neither model appears to have an advantage in this area. DPS Ex. 112 (Legursky 1/23/98) at 26.

Allocating Non-Facility Expenses

140. The purpose of the cost models is to develop a cost for the supported services on a per line basis. Thus, all costs must be assigned to lines. The parties to this proceeding have proposed two general methods for allocating general overhead and support expenses to lines. One approach is to allocate such costs based upon all or some subset of facility investments. The second approach is to allocate such costs on a per line basis, regardless of the differences in the amounts invested in each line. The FCC has tentatively concluded that the preferred model should provide the user with the capability to calculate each category of expense based on either an investment basis or a per line basis, at the user's election. FNPRM, ¶ 157. Both models generally comply with the FCC requirement that users be able to specify whether each category of expense should be allocated on a per line or per dollar of investment basis. DPS Ex. 115, EF 1 (1/23/98) at 41. Testimony at the hearing, however, indicated that with

some categories of expense, such as general and administrative costs and executive and planning costs, could not be entered into BCPM on an investment basis. Tr. 149. In general, it appears that only plant-specific expenses can be placed on either a per line or on an investment basis in BCPM. Tr. 163.

141. The DPS recommends that expenses related to the loop be spread on a per line basis rather than on an investment basis because parties have not shown such expenses are relatively greater for more costly loops. For example, there is no self-evident reason why furniture and office equipment expenses are relatively more used in connection with more expensive loops than with less expensive loops, yet the HM default is to assign none of these expenses on a per line basis. HM Inputs Portfolio § 5.3, AT&T/MCI Ex. 65, RAM-12. The Department recommends that all the expenses that should be allocated to the loop be totaled and then the total should be allocated to the loop on a per line basis. The effect of the Department's recommendation will be to allocate less expense to the higher cost loops that are largely found in the lower density zones. DPS Ex. 115, EF 1 (1/23/98) at 7. The ALJ agrees.

Network operations reduction

142. The HM uses a "Network Operations Reduction" reduces historical network operating expense in certain categories by a factor of fifty percent. The basis for the reduction is set forth in the HM Inputs Portfolio, Appendix D. AT&T/MCI Ex. 65, RAM-16. Dr. Mercer was cross-examined about the basis for the reduction at some length. Tr. 391-399, 603-604. In general, Dr. Mercer was only able to say that improvements to equipment and changes in the industry have created several opportunities for savings in operations, but that the changes are difficult to quantify.

143. U S WEST and GTE object strongly to this reduction. The objection is well-taken. There is, no doubt, always room for improvement, particularly in a field where technological advances that reduce human involvement are so common. However, a fifty percent reduction from what the ILECs are reporting is a very large reduction that inadequate support in the record. The ALJ finds that the reduction should itself be reduced to 25 percent. The ALJ does not know what change is required to implement that reduction.

Rate of Return

144. Universal Service Order ¶ 250(4) states: "The rate of return must be either the authorized federal rate of return on interstate services, currently 11.25 percent, or the state's prescribed rate of return for intrastate services. We conclude that the current federal rate of return is a reasonable rate of return by which to determine forward looking costs. We realize that, with the passage of the 1996 Act, the level of local service competition may increase, and that this competition might increase the ILECs' cost of capital. There are other factors, however, that may mitigate or offset any potential increase in the cost of capital associated with additional competition. For example, until facilities-based competition occurs, the impact of competition on the ILEC's risks associated with the supported services will be minimal because the ILEC's

facilities will still be used by competitors using either resale or purchasing access to the ILEC's unbundled network elements. In addition, the cost of debt has decreased since we last set the authorized rate of return. The reduction in the cost of borrowing caused the Common Carrier Bureau to institute a preliminary inquiry as to whether the currently authorized federal rate of return is too high, given the current marketplace cost of equity and debt. We will re-evaluate the cost of capital as needed to ensure that it accurately reflects the market situation for carriers."

145. U S WEST and GTE have both advocated alternative inputs for rate of return and depreciation lives, arguing that the values required by the FCC are not sufficiently "forward-looking." The effect of these proposed inputs is generally to increase the cost estimates produced by the models. At this point in time, there is no option to vary from the FCC prescribed rate. Nor is there sufficient evidence in this proceeding to create disagreement with the FCC's conclusions.

146. The ALJ agrees with DPS's position that the authorized federal rate of return, 11.25%, is the appropriate figure to use. More specifically, the Department supports the use of 8.8 percent for the cost of debt, 13.2 percent for the cost of equity, and a 44.3 percent fraction of debt, which values generate an 11.25 percent cost of capital. DPS Ex. 115 (Fagerlund 1/23/98) at 33. Each model can be run with these inputs. For purposes of this Universal Service support cost model proceeding, these inputs should be used until such time as the FCC changes the national standard.

Economic Lives

147. Universal Service Order ¶ 250(5) states: "Economic lives and future net salvage percentages used in calculating depreciation expense must be within the FCC-authorized range. We agree with those commenters that argue that currently authorized lives should be used because the assets used to provide Universal Service in rural, insular, and high cost areas are unlikely to face serious competitive threat in the near term. To the extent that competition in the local exchange market changes the economic lives of the plant required to provide Universal Service, we will re-evaluate our authorized depreciation schedules. We intend shortly to issue a notice of proposed rule making to further examine the Commission's depreciation rules.

148. The HM uses Minnesota-specific depreciation lives and net salvage values that are consistent with the values adopted by the Commission for each of the non-rural LECs included in this proceeding. AT&T/MCI Ex. 39 (Mercer 1/23/98) at 39. These Minnesota-specific depreciation lives and salvage values are within the range authorized by the FCC. For the BCPM, U S WEST submitted separate runs which reflect U S WEST's view of forward looking economic lives, lives prescribed by the MPUC and financial reporting lives, none of which are within the FCC's range for U S WEST. In both models, these are input values that can easily modified.

149. The Department's position is that the mid-points of the FCC ranges are the appropriate numbers to use and that either model would comply with this criterion if the mid-points of the FCC ranges for depreciation lines and salvage values are used in a

compliance run. If the FCC should reconsider its ranges at some future date, the Department would be willing to review its position. Ex. 115 (Fagerlund 1/23/98) at 36-37. The Department also believes that all carriers should use these same figures for purposes of the cost studies for the Universal Service support program. Using the same percentages would further the goal of uniform treatment of supported areas throughout the state. Id. DPS Brief at 14.

150. Again, compliance with ¶ 250 is required. U S WEST and GTE argue for shorter lives based partly upon speculation about the effects of competition. But they have not demonstrated that the FCC's conclusions are erroneous. Using the midpoints of the FCC ranges for all the carriers as recommended by DPS is reasonable at this point in time.

All Lines Included

151. Universal Service Order ¶ 250(6) states: "The cost study or model must estimate the cost of providing service for all businesses and households within a geographic region. This includes the provision of multi-line business services, special access, private lines, and multiple residential lines. Such inclusion of multi-line business services and multiple residential lines will permit the cost study or model to reflect the economies of scale associated with the provision of these services."

152. The models interpret the term "all households" differently and thus determine demand differently. It could be interpreted to mean total housing units (inhabited and uninhabited), total households (inhabited), or households with telephones. The numbers are significantly different--the 1995 Census estimate of “Total Housing Units” is 107,879,506, while the FCC Industry Analysis Division reports 100,000,000 total households and 94,000,000 households with telephones.

153. The HM models a network to serve households with telephones; it calculates per customer costs by dividing the cost of efficiently constructing and operating a network to serve households with telephones by the number of telephone lines demanded by these same customers. The HM uses the total demand for loops, switching, and interoffice transport presented by residential, business, public phone, and special access customers. The HM also allows the user to input data that represents the total non-switched line demand, including the percent of private line and special access voice grade equivalent circuits that are provided as DS-0, 4-wire DS-1, fiber DS-1 and DS-3, anticipating the possible future availability of such data on a consistently-reported basis from all LECs. Mercer Sec. Supp. Dir. (Ex. 59) at 17.

154. The BCPM includes specifically the cost of providing service to all households and businesses within a geographic region, whether or not those households or businesses currently take telephone service, including users of private line services. (Ex. 16, p. 13; Tr. 126, 158 (Copeland)). BCPM's more expansive definition of Universal Service serves to raise its cost estimates relative to the HM definition. BCPM would build more lines than the HM even if both have the same number of subscribers. Tr. 18-21.

155. The HM's interpretation appears to be correct. It is consistent with the requirement of ¶ 250(1) to use actual wire counts. The need to size the network to serve new customers is modeled by the use of fill factors. The BCPM interpretation oversizes the network and leads to an overstatement of costs. Moreover, the BCPM further compounds in its overstatement of costs by dividing the cost of providing service to all housing units by working lines. AT&T/MCI Ex. 80, (Klick 1/23/98) at 27; AT&T/MCI Ex. 81, JCK 10 at 6-8.

156. There is also a difference between the models in counting special access lines. They are non-switched lines that provide high-speed digital services, analog and digital data circuits, private-line, and other services. Some special access lines require a single pair (or two wire circuits) but others, including all digital services, require two pairs (or four wire circuits). DPS Ex. 113 (Legursky 2/3/98) at 2. Both the HM and BCPM permit the user to input the number of special access lines. The sponsors of each model, however, make different assumptions as to the appropriate number of special access lines. This number is important because the higher it is, the lower the average cost per line due to economies of scale in the construction of such lines. DPS Ex. 113 (Legursky 2/3/98) at 3. Mr. Legursky testified that special access lines should be counted one way in the distribution plant and another way in the feeder plant. In the distribution plant, special access lines should be counted on a "pair-equivalent" basis. That is, two pairs of wires (a four-wire circuit) should be counted as two lines regardless of how many circuits may actually be provided to customers over that facility. For example, a DS1 circuit is capable of providing up to 24 circuits or "lines" for customers but it only requires two pairs of wires in the distribution plant. DPS Ex. 113 (Legursky 2/3/98) at 4. Mr. Legursky reasoned that since only two pairs of wires need be installed in the distribution plant to provide a DS1 circuit, only the costs of installing those pairs should be included in total facilities costs and not the cost of installing a cable of 24 or more pairs or lines. On a pair equivalent method of calculation, there are 170,000 special access lines in U S WEST's territory in Minnesota. In the feeder plant, however, a different counting method, a "circuit-equivalent" method, is appropriate. Special access lines provisioned over fiber-fed digital loop carrier do not require cable pairs. For example, to operate at full capacity, a DS1 circuit in the feeder plant requires that 24 channels of the fiber's total channel capacity be available to it. Unlike distribution plant where a two-pair cable may provide 24 "lines" of services, in the feeder plant, 24 channels are needed to provide 24 "lines" of services. On a circuit-equivalent method of calculation, there are 616,000 special access lines in US WEST's territory in Minnesota. DPS Ex. 113 (Legursky 2/3/98) at 4.

157. Neither the HM nor the BCPM permit special access lines to be counted on a pair-equivalent basis in the distribution plant and on a circuit-equivalent basis in the feeder plant. Id. The HM counts special access lines on a circuit-equivalent basis. BCPM counts special access lines on pair-equivalent basis. The Department urges that the sponsors of the chosen model be directed to develop the capability to permit the distribution plant costs of special access lines on a pair-equivalent basis and the feeder plant costs of such lines on a circuit-equivalent basis. The ALJ agrees, and until such time as the recommended model has that capability, special access lines should be counted on a pair equivalent basis, given the predominance of distribution plant costs

relative to feeder plant costs in total loop costs. Special access line counts should be included in the runs of the HM for each of the four companies.

Joint and Common Costs Allocation

158. Universal Service Order ¶ 250(7) states: "A reasonable allocation of joint and common costs must be assigned to the cost of supported services. This allocation will ensure that the forward-looking economic cost does not include an unreasonable share of the joint and common costs for non-supported services."

159. The BCPM allocates joint and common costs as a dollar per line amount. USW Ex. 16 (Copeland 10/24/97) at 14). In Minnesota, that amount is $2.53 per line, per month. USW Ex. 16, Ex. PBC-2. That amount is a variable percentage of total operating expenses, ranging from 14.44% to 15.66%, depending on the assumptions about depreciation expense which are reflected in the runs. This is a user adjustable input. The model sponsors provided no explanation for how they derived these values. DPS Ex. 115, EF 1 (1/23/98) at 40.

160. The HM also allows the overhead factor to be set by user input. The HM uses a default input factor of 10.4% for overhead costs for Universal Service, a factor that based on AT&T's own 1994 reported overheads to the FCC in AT&T's Form M. This default value is not reasonable. There is no basis for applying AT&T's overhead factor in 1994 to ILECs today. The actual overheads that U S WEST has recently incurred, are higher than the AT&T 10.4%. Dr. Fitzsimmons testified that this number is 14.1%. (Tr. 282) The AT&T revenue upon which the ratio is based inappropriately includes access charges. USW Ex. 45 (Fitzsimmons 1/23/98) at 43-44.

161. The Department is not endorsing a particular percentage overhead factor in this proceeding because it had not performed its own independent analysis of this factor. The Department recommended that until such time as a different percentage is demonstrated to be more accurate, the 14.1% overhead factor suggested by U S WEST is a more reasonable estimate for an efficient firm providing local telephone service than the percentage used by AT&T.

162. In testimony filed in the U S WEST generic cost docket on March 2, 1998, DPS Rates Analyst Gregory Doyle testified in favor of a 15.41% common overhead factor that he developed to be used in the HM. That has not been offered in this proceeding, and it may not have application beyond U S WEST, but it does confirm that the 14.1% overhead factor suggested by Dr. Fitzsimmons is reasonable. The ALJ concludes that the HM input should be changed to 14.1%.

163. The FCC made several tentative conclusions regarding the allocation or assignment of port costs to Universal Service. The FCC tentatively concluded that switch costs should be divided between port and usage costs, and that all of the port cost and only a percentage of usage costs associated with local service should be allocated to Universal Service. FNPRM ¶ 137. Mr. Morrisette testified that because there are not likely to be switching capacity constraints, this division will not provide

increased efficient use of the network and will simply lead to a greater probability of over- or under-recovery of switching costs. As such, switching costs should not be divided between port and usage functions, and the BCPM approach of estimating switching costs on a per-line basis should be adopted. OAG Ex.109 (Morrisette 11/24/97) at 41-42. The FCC also tentatively concluded that 100 percent of the loop and 100 percent of fixed switching costs should be allocated to basic local service. FPNRM ¶ 135. Mr. Morrisette states that this conclusion is contrary to current MPUC policy and state law, which allocate a portion of the cost of the loop to interstate long distance traffic. He suggests that there are many other ways to approach this issue and the MPUC should not make a cost allocation decision in this case that will ultimately affect intrastate rates and rate design or, for that matter, any state Universal Service decisions. OAG Exh.109, p.50. The ALJ offers no opinion on the OAG position. The models comply with the FCC requirements.

Open and Verifiable

164. Universal Service Order ¶ 250(8) states: "The cost study or model and all underlying data, formulae, computations, and software associated with the model must be available to all interested parties for review and comment. All underlying data should be verifiable, engineering assumptions reasonable, and outputs plausible."

165. In general, both models meet this criterion. Their formulae and software are available for review. DPS Ex. 115 (Fagerlund 1/23/98) at 42. However, both models rely upon preprocessing done outside of the models as filed. Those outside routines and models are difficult to review and verify.

166. Mr. Klick testified that the BCPM preprocessing is not open, the source of the inputs used by U S WEST and GTE are not verifiable, and that the BCPM feeder design assumptions are not modifiable because they are buried in the preprocessor. Klick Reb. (1/23/98) (Ex. 80) at 12-13. Further, the BCPM relies on either Bellcore's SCIS model or U S WEST's SCM model to determine its switching costs, which rely on the proprietary algorithms and inputs to Bellcore's or U S WEST's models and require extensive LEC-designated data inputs that are unknown and undocumented. Id. at 16-17. Similarly, the transport module lacks appropriate documentation of the model's algorithms, which makes the calculations impossible to examine. Id. at 22-23 and 55. The same is true for signaling costs. Id. at 55 and 57.

167. U S WEST responds that the BCPM's preprocessing and signaling module are available for download on the World Wide Web at http://www.bcpm2.com, that the software associated with the model is available at nominal cost and that the underlying data, formulae and computations are available publicly, on the record in this case; or, if confidential, may be reviewed through the signing of a protective agreement. (Ex. 28, p. 5). USW Brief at 42-43.

168. U S WEST complains about the HM's geocoding and clustering process being impossible to examine. Dr. Emmerson testified that PNR had categorically refused his firm's request to purchase the underlying information, claiming that it is proprietary. (Ex.

6, p. 10) He further testified that he was unable to recreate the information from other sources because some of it simply was not available. (Tr. 63 (Emerson)) Mr. Copeland introduced the further evidence on this point; PNR's written refusal to provide a license to any of the information, even that which was not a database belonging to Metromail or Dun and Bradstreet. (Ex. 29, Sub-Ex. PBC-2) The stated basis was that the information was proprietary to AT&T and MCI. Even Dr. Mercer was at a loss to explain why a data request to those parties was insufficient to result in production of at least the AT&T and MCI proprietary information. (Tr. 53, 354). USW Brief at 45. U S WEST also argues that AT&T has provided no binding assurance that it will continue to support the model and that MCI has given no indication at all that it will support the model in the future. USW Brief at 49.

169. MCI and AT&T cite several reasons why the HM customer location process was subject to review, verification and comment. First, the customer location process is explained in detail in the Model documentation. The Metromail and D&B databases that are used are described in Sections 5.4.1 and 5.4.2 of the HM 5.0 Model Description and the procedures used by the geocoding software, Centrus Desktop, to convert addresses into latitude and longitude geocodes are described at Section 5.4.3. Ex. 130 at 2-4. Second, although Metromail and D&B's underlying databases, Centrus Desktop's software and PNR's NALM are not available as a whole without payment to the entities that own that commercially valuable information, the information is, contrary to U S WEST's assertion, open to public view and commercially available. In fact, despite its criticism, U S WEST's witness Emmerson was able to evaluate the data and opine that coverage of the data was incomplete. Emmerson Reb. (1/23/98) (Ex. 5) at 11-12. Further, the HM sponsors are willing to aid any commission that chooses the HM with ongoing maintenance of the Model. Id.; Tr. 832-835. Contrary to U S WEST's implication, the Commission need not purchase the Metromail and D&B databases, the Centrus Desktop software, or PNR's National Access Line Model in order to use the HM 5.0a as its Universal Service cost proxy model. Id. MCI/AT&T Brief at 29-30.

170. There are parts of both models that are not easy to examine for a variety of reasons. The HM's clustering process is of particular concern because it determines feeder and distribution design, which constitutes a large part of loop expense. PNR is not an outside, neutral vendor of an off-the-shelf product. Rather, it was retained by MCI and AT&T to develop the clustering software because it is a firm that specializes in creating the type of database and model needed to do the geocoding and clustering. Dr. Mercer's company was not involved in the design of the clustering program, but it, along with AT&T and MCI, have reviewed its operation extensively. Tr. 582-583. Thus, MCI, AT&T, PNR, and HAI Consulting, Inc., had all the underlying information available to one or another of them and could have been more forthcoming with it. But Dr. Emmerson was able to use the information provided by AT&T and MCI, together with databases and information he was able to obtain elsewhere, to do an adequate analysis of the clustering process. His testimony, along with the documentation and testimony provided by the HM sponsors, allowed a thorough understanding and reasonable examination of that process by all concerned. The arguments regarding the cost to the Commission if it wishes to review the PNR process at some future point are specious. That is not a necessary process at this point. If it is necessary in the future to rerun the

clustering routine, any expenditure not covered by the sponsors can be paid out of the Universal Service or high cost funds. Beyond that, what might happen in the future is purely speculation.

171. The fact that the BCPM sponsors made information about its preprocessing modules available on a website is also inadequate. It would have been better if they had informed interested parties that the information had been posted there. When was it posted? Why is the web site still called "bcpm2.com"? Despite these failings, adequate information has been available to examine the algorithms and data and the BCPM and the HM generally comply with the requirements of ¶ 250(8) regarding the outside preprocessing. Likewise, the engineering assumptions of both the BCPM and the HM are reasonable and their outcomes are plausible.

Capability to Examine and Modify Inputs

172. Universal Service Order ¶ 250(9) states: The cost study or model must include the capability to examine and modify the critical assumptions and engineering principles. These assumptions and principles include, but are not limited to, the cost of capital, depreciation rates, fill factors, input costs, overhead adjustments, retail costs, structure sharing percentages, fiber-copper cross-over points, and terrain factors.

173. The HM has been subject to public scrutiny in numerous state and federal proceedings over the last three years. Except for the preprocessing module, the HM allows a user to modify the critical assumptions and engineering principles, including those listed by the FCC in ¶ 250(9). Users can change any of the inputs or the model logic and re-run the model using the modified inputs. Mercer Sec. Supp. Dir. (Ex. 59) at 17; Klick Reb. (1/23/98) (Ex. 80) at 57-58. MCI/AT&T Brief at 32.

174. U S WEST witnesses complain that many of the HM's critical engineering assumptions are reflected only in the complex computer code of the model and that important parameters are not available to the user through the user input forms that the HM provides. That is true of both these models. They both have become so complex that they may have exceeded the capacity of a spreadsheet program like Microsoft Excel to program the algorithms of the models and to allow easy examination of the programming. Nevertheless, the fact is that spreadsheets, Microsoft Access databases, and Visual Basic routines were provided for examination. In addition, Mr. Schaaf and Dr. Fitzsimmons did thorough examinations and pointed out what they viewed as several flaws in the HM.

175. Approximately six hundred of the fourteen hundred user adjustable inputs to the HM are based upon the opinions of the HM outside plant team. Tr. 380-81. U S WEST argues that their task and their own self interest was to keep the pricing inputs to the model as low as possible and that they adopted default and other user adjustable engineering and pricing inputs to accomplish that financial objective and withheld information that would unequivocally confirm this activity. USW Brief at 52. The biases of the parties and witnesses have been discussed above and considered in evaluating the testimony. Again, U S WEST had the HM inputs documentation and was provided

with discovery responses, all of which was more than sufficient to allow it to prepare and present its case.

176. The BCPM meets this requirement to the same degree as the HM. Critical assumptions and engineering principles of the BCPM can be examined and, except for the preprocessing modules, can be modified. USW Ex. 16 (Copeland) at 15.

177. In general, both models provide for the ability to examine and modify the principal assumptions and input parameters. DPS Brief at 20.

Small Geographic Areas

178. Universal Service Order ¶ 250(10) states: "The cost study or model must deaverage support calculations to the wire center serving area level at least, and, if feasible, to even smaller areas such as a Census Block Group, Census Block, or grid cell. We agree with the Joint Board's recommendation that support areas should be smaller than the carrier's service area in order to target efficiently Universal Service support. Although we agree with the majority of the commenters that smaller support areas better target support, we are concerned that it becomes progressively more difficult to determine accurately where customers are located as the support areas grow smaller. As SBC notes, carriers currently keep records of the number of lines served at each wire center, but do not know which lines are associated with a particular CBG, CB, or grid cell. Carriers, however, would be required to provide verification of customer location when they request support funds from the administrator."

179. The HM satisfies this requirement. It calculates cost by cluster and the results can be displayed by cluster, or aggregated and displayed by wire center, line density range (of clusters), or Census Block Group. The BCPM also meets this requirement. It calculates costs by ultimate grid, which may be as small as a microgrid, 1,500 feet by 1,700 feet in most densely populated areas, or as large as a macrogrid, approximately five square miles in least densely populated areas. The grids can be aggregated by wire center, line density range (of grids), or in any geographic unit that may be desired. However, that would require an extra step of doing the designating of which grids are within each geographic unit. Tr. 186-190.

180. DPS does not recommend deaveraging support calculations to areas smaller than the wire center because the incumbent local exchange carriers do not currently keep information on the geographic locations of lines for areas smaller than wire centers. Tr. 1122-23. DPS argues that It is not fair to the public if areas smaller than the wire center are used at this time because without accurate line counts, it cannot be ensured that all neighborhoods having the same demographic characteristics will have the same costs associated with their lines. Similarly, the OAG argues that given the current difficulty in mapping customers to a specific wire center, the results become even less reliable in smaller areas where there is no basis for comparing modeled lines to actual lines, and thus, the wire center should be the smallest base for universal support. OAG Exh.109, p.51. OAG Brief at 41.

181. The ALJ sees no need within the models to limit the support area to something no smaller than a wire center. While carriers only maintain actual wire counts by wire center today, the models can produce reasonably accurate estimates of line counts at the grid or cluster level, particularly if they are normalized to the actual counts at the wire center level. When the grids or clusters are aggregated (or disaggregated) to other geographic areas such as CBs, CBGs, or Zip Code areas, the line counts remain sufficiently accurate for determining the cost of providing Universal Service in those areas. While population, soil type, and other inputs derived from information for larger geographic units or density range estimates are not perfect, it is the best information available for the smaller units and the overlap of many different inputs creates reasonable accuracy at the smaller levels. More importantly, the smaller units more accurately reflect distance from the wire center and therefore more accurately reflect distribution and feeder plant costs. Because the cost data provided by the models for geographic units smaller than the wire center are reasonably accurate, they may be used with confidence to establish Universal Support at the CB, CBG, or similar geographic unit level.

182. Reasons other than accuracy affect the choice of the geographic unit used for determining Universal Service support and are only be mentioned briefly here because they need not be decided in this proceeding. One is the problem encountered by the carriers when requesting support payments--they must show the number of customers they have within the designated areas. If the unit is something other than a wire center, they will have to develop methods for identifying their customers to the designated areas. The FCC has stated in ¶ 250(10) that that will be the obligation of the carriers.

183. AT&T witness Baker suggested that Universal Service support be calculated on a company service area basis. She noted that the change in AT&T's position reflects its difficulty in entering local markets. Tr. 836. The result of the proposal would be that U S WEST and GTE would not receive any support, at least at currently anticipated support levels. Tr. 857-858. The underlying reason for the proposal is that AT&T considers it unfair and contrary to the reforms under the 1996 Act to start paying explicit subsidies to ILECs before all the implicit subsidies are removed. Tr. 861-862. The ALJ agrees that doing so could cause the ILECs to receive windfall Universal Service payments, but this is a timing and administration issue that should be addressed in other proceedings.

184. The OAG voiced a similar concern, stating it was reluctant, as a policy matter, to endorse use of support areas which are smaller than the total company and suggesting an alternative: wait until a new entrant chooses to enter a remote area where costs exceed the federal revenue benchmark and only then establish these areas as new zones eligible for Universal Service funding. The OAG suggests that this approach would better meet the policy of encouraging competitive entry in both rural and urban areas without damaging sustainability for Universal Service over the long run. OAG Brief at 41-42. The ALJ considers this an unworkable solution.

185. The Department also suggests that density zone calculations should be developed so that wire centers could be assigned to density zones using the density of

the wire centers, and the Commission should require this procedure to be done as part of the compliance run. Both the HM and BCPM have this capability. DPS Brief at 21. The ALJ finds that such a report may provide some additional information that would be helpful, but because a "density zone" is not a geographic area, it should not be used for setting support.

Selection of Cost Study

186. The Department strongly endorses the HM because it believes the HM will better accomplish the FCC's goals for two principal reasons. First, it has a more accurate system for locating customers than BCPM and it minimizes reliance on surrogate location techniques. Second, the HM's switching module generates more accurate switching costs than BCPM's SCM module. For both these reasons, the Department believes that the HM will generate a more accurate prediction of the distribution network and its associated costs. Moreover, the HM meets the FCC's ten criteria in ¶ 250. DPS Brief at 54-55.

187. The OAG believes that the evolving efforts to improve the models have been undertaken in good faith and that both models are improved over earlier versions, but that the neither has yet been shown to be a better predictor of cost. Thus, the OAG proposes the use of a blended cost model as both appropriate and consistent with the FCC's directive to states because it balances deficiencies in either model by giving them equal weight. The OAG recommends that rather than discarding the results of either of these efforts, the Commission should recommend a blended cost model at this time. OAG Brief at 4-5.

188. The ALJ finds the OAG's proposal interesting, but unworkable and unnecessary. As demonstrated many times, the two models reflect the opposite biases of their sponsors in their designs and inputs, so it is tempting to split the baby. In fact, in the case of some specific inputs, that approach has been recommended. But treating the two models equally on an overall basis is obviously wrong; the HM is much closer to being in line with the FCC standards and needs relatively few and minor adjustments to be made appropriate for use in Minnesota. Moreover, it would be very time consuming and expensive to do the blending process in a form that would qualify as a "study."

189. The ALJ concludes that the HM, with the modifications of inputs and other changes recommended in this report, should be selected as the cost study to be submitted to the FCC. It meets the requirements of ¶250 better than the BCPM. In particular, and most importantly, it best reflects "the least-cost, most-efficient, and reasonable technology currently being deployed," and "long-run, forward-looking, economic costs." Compliance to these standards is apparent throughout the model's design, logic, and inputs. For those instances where the HM is too low cost, overly efficient, or inaccurate, the modifications of inputs and other changes have been recommended to insure that the cost determinations are reasonable.

Use of Selected Model for UNEs and State study.

190. Universal Service Order ¶ 251 requires the state cost study submitted to the FCC for the purposes of calculating federal universal service support to be the same cost study that is used by the state to determine intrastate universal service support levels. It also encourages a state, to the extent possible, to use its ongoing proceedings to develop permanent unbundled network element prices as a basis for its universal service cost study. At this time Minnesota does not have an intrastate universal service support mechanism for non-rural LECs. A docket is currently open in which the MPUC will consider the appropriate cost model for unbundled network elements. MPUC DKT. No. P-422, 5231, 3167, 466, 421/CI-96-1540. The evidentiary hearing in that docket is scheduled for April 20, 1998 through May 1, 1998.

191. MCI and AT&T suggest that the HM should be selected both in this proceeding and the U S WEST generic cost proceeding because consistency in determining costs, whether in the context of Universal Service support or pricing of UNEs, is necessary in order to send consistent economic signals to the marketplace and mimic the economic incentives that are present in competitive markets. Klick Reb. (1/23/98) (Ex. 80) at 6-7. See also Mercer Sec. Supp. Dir. (Ex. 50) at 18-19. MCI/AT&T Brief at 4. U S WEST calls this argument illogical and not based on fact because neither of the two models is capable of modeling costs for all unbundled network elements, the choice of model for unbundled network elements has not yet been made in Minnesota, and the FCC did not say or imply that it would disapprove a state cost study, if that study was not the same study which the state uses for costing Universal Service elements. The OAG agrees and adds that the studies selected in this proceeding need not be used in establishing a high-cost state Universal Service fund. OAG Brief at 3.

192. This proceeding is only for selecting the cost study to be submitted to the FCC for use by the FCC in determining the federal share of Universal Service support. There will no doubt be precedential value to the determinations in this proceeding, but it is possible that the cost studies selected for other purposes may be different.

Based upon the foregoing Findings and Conclusions, the Administrative Law Judge makes the following:

RECOMMENDATION

THIS REPORT IS NOT AN ORDER AND NO AUTHORITY IS GRANTED HEREIN. THE MINNESOTA PUBLIC UTILITIES COMMISSION WILL ISSUE THE ORDER OF AUTHORITY WHICH MAY ADOPT OR DIFFER FROM THE FOLLOWING RECOMMENDATIONS.

IT IS HEREBY RESPECTFULLY RECOMMENDED that the Minnesota Public Utilities Commission:

1. Select the HM 5.0a, with the following input value and other modifications, as its cost study for use by the FCC for the determination of the costs of Universal Service supported services for non-rural telephone companies in Minnesota for the year 1999:

Input Changes

a) Set cost of capital at 11.25% to meet FCC requirements.

b) Set depreciation parameters at midpoints of FCC ranges for projection lives and net salvage percentages to meet FCC requirements.

c) Use the HM default regional labor adjustment factor for Minnesota (.99).

d) Adopt the U S WEST study drop lengths by density zone as set out in Dr. Fitzsimmons' testimony.

e) Use the following distribution structure mix parameters as described by Mr. Legursky:

Density	Aerial %	Buried %	Underground %
0-5	18.0	78.0	4.0
6-100	14.0	80.0	6.0
101-200	9.0	81.0	10.0
201-650	5.0	84.0	11.0
651-850	3.0	85.0	12.0
851-2550	2.0	85.0	13.0
2551-5000	1.0	85.0	14.0
5001-10,000	1.0	84.0	15.0
10,000+	0.0	84.0	16.0

f) Use the structure sharing parameter described by Mr. Legursky of 66%.

g) Set the fraction available for shifting away from the preassigned structure mix equal to zero.

h) Use the following buried placement cost parameters described by Mr. Legursky.

Density Group	Recommendation
0-5	1.62
6-100	1.80
101-200	3.12
201-600	3.84
601-800	5.22
801-2550	5.90
2551-5000	6.49
5001-10,000	9.47
10,000+	10.41

i) Use 14.1% for overhead expense factor.

j) Increase the expense inputs affected by the "Network Operations Reduction" to reflect a change in that factor from 50 percent to 25 percent.

k) Spread network operations, other taxes and variable overhead expense items related to general loop support on a per line basis.

l) Assign all other general support expenditures related to the loop on a per line basis.

Processing Changes

m) Run with current actual line counts by wire center for all companies.

n) Remove 32 sold exchanges from U S WEST in inputs database.

o) Consolidate GTE territories in inputs database.

Model Changes

p) Modify model to count special access lines on a pair-equivalent basis in the distribution plant and on a circuit-equivalent basis in the feeder plant.

q) Modify model to include costs of dedicated idle lines.

2. Order that MCI and AT&T cause the HM 5.0a to be run with the input value modifications and other changes listed above and provide the results in printed and electronic form, with along the inputs and outputs in the form required by the FCC in Public Notice DA 98-217, to the Commission and other parties by a date set by the Commission's Order.

3. Order that GTE, Frontier, Sprint and U S WEST provide, subject to the Protective Agreement in this matter, actual wire counts by wire center in useable electronic form for all their wire centers in Minnesota for use in the compliance run and that such wire counts include idle dedicated lines. If any such counts are not provided, the compliance run may be completed for that company by the HM's standard procedure of normalizing wire counts on a carrier-wide basis using publicly available counts.

Dated this 2nd day of April, 1998

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STEVE M. MIHALCHICK
Administrative Law Judge

NOTICE

Notice is hereby given that, pursuant to Minn. Stat. § 14.61, and the Rules of Practice of the Public Utilities Commission and the Office of Administrative Hearings, exceptions to this Report, if any, by any party adversely affected must be filed within 20 days of the mailing date hereof with the Executive Secretary, Minnesota Public Utilities Commission, 350 Metro Square, 121 7th Place East, St. Paul, Minnesota 55101. Exceptions must be specific and stated and numbered separately. Proposed Findings of Fact, Conclusions and Order should be included, and copies thereof shall be served upon all parties. If desired, a reply to exceptions may be filed and served within ten days after the service of the exceptions to which reply is made. Oral argument before a majority of the Commission will be permitted to all parties adversely affected by the Administrative Law Judge's recommendation that request such argument. Such request must accompany the filed exceptions or reply, and an original and 15 copies of each document should be filed with the Commission.

The Minnesota Public Utilities Commission will make the final determination of the matter after the expiration of the period for filing exceptions as set forth above, or after oral argument, if such is requested and had in the matter.

Further notice is hereby given that the Commission may, at its own discretion, accept or reject the Administrative Law Judge's recommendation and that the recommendation has no legal effect unless expressly adopted by the Commission as its final order.